University of Alberta

Assessing Recreation Values at Risk from Wildfires in Alberta

by

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To the countless many that made this journey miserable, fun, exciting, painful, repetitive, awe-inspiring, satisfying, adventurous, boring, fulfilling, mundane, important, challenging…….

Thank you!

Abstract

This study outlines the importance of including outdoor recreation values in forest fire management in Alberta. Rather than assume that existing recreation infrastructures reflect recreation values, we propose an alternative valuation framework based on econometric models of recreation participation. The results indicate that recreation values are not necessarily tied to the availability of recreation infrastructures. The high value recreation sites are located in southern Alberta particularly along the Mountain and the East Slopes Regions. The implications of this spatial distribution of recreation activity on current fire management framework are analyzed and policy recommendations made.

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Chapter 1
Introduction

1.1 Background

The levels of participation in various types of outdoor recreation are substantial in the forested areas of Canada. The 1996 National Survey on the Importance to Canadians (NSINC), for example, found that Canadians spent approximately 195 million user days, representing approximately 86% of total recreation user days, in recreational activities in forested lands (Williamson et al. 2002). This leads to two implications for forest and recreation management agencies. First, recreation has significant social and economic value that should be reflected in management decisions if sustainable forest management is to be achieved. This has resulted in the selection of measures of recreation participation as one of the relevant indicators of sustainable forest management reporting in Canada (CCFM 2000). Second, collecting recreation use statistics restricted to parks and other managed recreation areas may underestimate total recreation use in a jurisdiction. For example, Williamson et al. (2002) found that the majority of recreation activities in forested lands during 1996 occurred outside of parks and protected areas.

Presence of these activities has implications for fire management agencies. These include, first, protection of people who are present in fire prone forests. Second, in addition to property, infrastructure and timber values, forests provide recreational values which are at risk of loss from wildfire. This suggests that recreation should be a component of any fire management framework. However, it is unlikely that all recreation sites are visited equally. For example, of more than 500 sites included in Alberta's network of parks and recreation areas, ten sites accounted for the majority of the visits (Alberta Community Development 2001). Thus, an effective fire management framework must account for this varied visitation rate in allocating for management resources and for cost-benefit analysis (CBA) of fire management expenditures.

The impetus for CBA in fire management has recently been provided by tightening fiscal environments in many Canadian provinces. A policy of total suppression of all wildfires is being questioned as fire managers increasingly face resource constraints (Hirsch et al. 2001). Given these constraints, a CBA of suppression effort may be warranted. In the case of fire suppression, the majority of the cost elements are relatively easy to derive. They include equipment, personnel and other resources whose costs are normally denominated by some monetary amount. For goods traded in an economic market, such as timber, the benefits of suppression can be relatively easy to derive. However, assigning economic values to some of the forest resource benefits like recreation is a difficult task. This arises because many recreation assets and amenities can be classified as either pure public or quasi-public goods and as a result do not have market prices associated with them. The major advantage of incorporating recreation values is that their inclusion can provide a more complete benefit component in a cost benefit analysis of wildfire suppression. This framework can be used to prioritize allocation of fire fighting resources. For example, during multiple fire events, recreation values can be used to distinguish high priority fires and allocate resources accordingly.

Although not the focus of this research, recreation value is also implicitly linked to human life which is considered the highest values at risk from wildfire. Thus, protection of high value recreation areas can assist the fire management goal of protecting highest values at risk as well as identifying areas of the landscape where suppression efforts are to be directed. However, several cautions are warranted in including recreation values in any CBA. First, unlike some of the costs, recreation is a flow resource, providing a stream of benefits annually. Second, the assumption of complete loss of recreation value due to fire may not be valid. It is likely that recreationists substitute away to other areas or may even be attracted by the fire altered landscape. Third, research suggests that recreation benefits following a fire are not zero but follows a non-linear path as the forest recovers. This eventual recovery of forests and potentially recreation values need also to be accounted for in any CBA.

There have been a variety of methods proposed for valuing environmental amenities such as recreation. Some of these include travel cost models, which invoke the concept of weak complementarity. However, many of these models depend upon relatively expensive and time consuming collection and processing of visitor survey information at each site of interest (Brainard et al. 2001). Furthermore, these models often do not adequately take advantage of the spatial nature of outdoor recreation data.

In light of these facts, the study presented in this thesis demonstrates how recreation demand can be modeled using biophysical attributes of sites and attempts to explicitly incorporate the spatial nature of visitation data.

1.2 Study Objectives

The objectives of this study are as follows: i) To develop spatially explicit indicators and models of forest recreation to be incorporated into a fire management zoning scheme or values-at-risk map (VARM) for the province of Alberta; and ii) To predict spatial patterns of recreation activity that may be useful in allocating resources for evacuation in an event of fire.

These objectives will be developed by examining recreation data for the province of Alberta. The forest areas for which the Alberta Department of Sustainable Resource Development (SRD) has mandate for fire management and other areas will be examined. Two primary sources of data are used. The first is the 1996 National Survey on the Importance of Nature to Canadian (NSINC) which is the only available source of information on spatial patterns of recreation for the whole province. The second involves a compilation of existing data on recreation in one region of the province and the supplementation of this data with expert judgments. The purpose of this second data source is to investigate and highlight the presence of recreation activity not associated with specific managed recreation areas such as parks.

The overall objective of this thesis is to develop information and an approach to explicitly account for recreation values in forest fire management. Chapter 2 provides an overview of fire management policy in Alberta, including recent fire statistics and knowledge to date on the impact of wildland fire on recreation. Chapter 3 presents the data sources used in the thesis and the availability of recreation data for Alberta.

A provincial analysis of recreation values at risk is conducted in Chapter 4. This analysis examines the current framework for incorporation of recreation values and suggests an alternative framework based on econometric models of recreation participation. The chapter concludes with a short case-study on the effect of Chisholm fire on recreation value in that region.

Chapter 5 presents analyses of recreation data from the East Slopes Region. This Region is highly sought for recreational activities in Alberta and represents an area where "finer" measures of the spatial pattern of recreation may be useful. The goal of this chapter is to more accurately predict the extent of recreation activity in the region by collecting expert judgment data and other existing information from the local land management agencies.

Finally the overall results are summarized in Chapter 6 and some conclusions will be drawn. This final chapter will review the research objectives, limitations of the study and provide some directions of future research.

Chapter 2
Fire Management in Alberta

2.1 Introduction

Forests cover approximately 60% of Alberta's landmass and the majority of these forests are located on provincial Crown lands (SRD 2003). In addition to supporting industrial activities such as timber extraction and mining, the forests also provide numerous opportunities for outdoor recreation. Fire is also a natural part of the forest landscape in the boreal and montane/foothills regions (Weber and Stocks 1998). However, as human activities have increased in these forests, human-caused fires have become more common. The Government of Alberta, through its Forest Protection Division, seeks to minimize and reduce the impact of wildfires on people, property and resources. While the Program's initial mandate was to cover settled parts of the province, the development and the accompanying growth in settlement and infrastructure has required the program to provide a high level of protection for a majority of forest land in the province.[1] This is partly the result of the program's broad mandate and an absence of specific guidelines.

2.2 Policy Framework for Fire Management in Alberta

Fire management in Alberta has been driven by the broadly stated goals of reducing the impact on people, property and resources (Alberta Fire Review 1999; Chisholm Fire Review Committee 2001). Specifically, firefighting resource allocation priorities in decreasing order of importance are: protection of human life, communities, sensitive watershed and soils, natural resources and infrastructure (SRD 2003). The

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[1] An exception is in northern Alberta where after an initial suppression effort, fires are allowed to burn if there are no significant values at risk.

Department of Sustainable Resource Development (SRD), through its Forest Protection Program, is tasked to deliver on these goals. In order to carry out this mandate, the department has created the Forest Protection Area which corresponds roughly to the existing forest lands, excluding the National Parks, in the province (Figure 1).

In its early history, the forest protection program was confined to settled areas of Alberta where people would be most affected by the destructive force of fire. In areas of low human settlement, forest protection received low priority (Alberta Fire Review 1999). However, as the province continued to develop its natural resources, settlements grew and community dependence on forest resources increased. In response to these developments, the Forest Protection Program evolved to offer protection to people, property and resources in all forested lands. Given its broad mandate, high level policy objectives such as protecting Alberta's forest and forest communities by preventing and suppressing wildfires have been translated into a decision to provide a very high level of forest protection across the entire province (SRD 2003; Alberta Fire Review 1999). Furthermore, Alberta has no zones or areas identified where different levels of protection are provided. As a result, decision makers responsible for forest protection have interpreted the broadly stated mandate as support for very high levels of protection for the entire province (Alberta Fire Review 1999). In addition to these broadly stated goals and objectives, there are specific criteria which the department follows in fire management.

The Forest Protection Program consists of three components: preparedness, wildfire management and fire insurance (SRD 2003). Preparedness centres on prevention, readiness, detection and early response. Prevention is a key component of preparedness and includes activities such as risk and hazard communication through information bulletins and limiting and or restricting access to public forests during high hazard conditions. A key performance measure of prevention is to keep human-caused fires within Forest Protection Area from increasing. Other performance measures in preparedness include detection of wildfires when they are at 0.1 hectares or less in size and timely and effective response to emerging wildfires. Wildfire management involves containing the fires at or before they reach four hectares and containing the wildfires during the first burning period.[2] Fire insurance is designed to stabilize the Forest Protection budget and cover the exceptional costs of fighting wildfires.

2.3 Alberta Fire Statistics

During the last decade, there were on average 963 fires per year which burned an average of 200,000 hectares annually (SRD 2003). Lightning caused fires accounted for majority of the fire starts (59%) and burned 75% of the total area. Human-caused fires accounted for 41% of the fire starts and burned 25% of the total area (ibid). The average annual cost of wildfire suppression has been $70 million over the last decade. However, these averages mask a substantial variation in fire activity and costs such as the 1998 fire season which burned over 700,000 hectares and suppression costs were $242 million (Alberta Fire Review 1999).

2.4 Values at Risk in Fire Management

Values at risk is defined as "community assets such as people, places and natural resources that may be lost during a wildfire" (Chisholm Fire Review Committee 2001). The concept of a value-at-risk in fire management framework has also been applied in other jurisdictions. For example, in 1990 the Government of Northwest Territories (NWT) introduced a fire management policy which dictated that all fires were to receive a response based on several criteria; the first criterion was the values-at-risk (Clark 1993). Although not explicitly stated, Alberta's fire management framework does allow for value-at-risk concepts. The goal of reducing the impact of fire on people, property and resources can be seen as prioritizing values-at-risk. Recreation values at present are not specifically included. However, these values are currently assumed to be reflected through the presence of recreation infrastructure such as parks and recreation areas at a site. The implicit assumption is that the costs of replacing lost recreation infrastructure due to fires at the sites determine the economic values associated with recreation use.

---

[2] First burning period is usually referred to as the 24 hr time period after first detection of a fire.

Alberta's network of parks and recreation areas covers roughly 27,500 km^2 and includes more than 500 sites (Alberta Community Development 2004). The recreation infrastructure is contained mostly within this network, although some privately provided infrastructure also exists. This recreation infrastructure includes campgrounds, picnic tables, buildings and structures, roads and other associated infrastructure.

The spatial distribution of this infrastructure is shown in 100 km^2 grids in Figure 2. The majority of the recreation infrastructure is located along the mountain and foothills regions bordering the Jasper, Banff and Waterton National Parks. Other areas include the Peace River Region and the Cold Lake Region. However, the south eastern parts of Alberta relatively few recreation infrastructures. Note that the National Parks also contain recreation infrastructure. However, these Parks lie outside of the Forest Protection Area of Alberta and thus are excluded from provincial fire management activities.

Recreation economic values, however, should also include the value associated with participating in the activity, and this participation may be or may not be associated with publicly provided recreation infrastructure such as campgrounds and parks. Thus, explicit consideration of recreation values in allocating resources would be advantageous in that these values are closely linked to the presence of recreationists and not necessarily infrastructure. Therefore, during fire events, directing resources to high value recreation areas can fulfill a fire management goal of protecting highest values at risk, as well as identifying areas of the landscape where the suppression efforts are to be directed. Thus, recreation values can be used in a benefit cost framework for more efficient allocation of fire fighting resources.

2.5 Impacts of Wildfire on Recreation

Wildfires are a common occurrence in many forested regions of Alberta. Over 75% of the forests in Alberta have burned in the past 50 years (SRD 2003). These forests also provide numerous opportunities for outdoor recreation. However, there are numerous impacts of wildfire on recreation activities. Some of these impacts include the destruction of recreation infrastructure, changes in the landscape aesthetics and restrictions and/or inability to access forested areas for recreation. For example, due to the high fire danger experienced in many parts of Alberta's forests, SRD has frequently introduced fire bans and in some cases closed forest access to recreationists (Wilton 2003). These actions are designed primarily to minimize the risk of fire ignition and/or minimize the risk of recreationists perishing in a fire. While these actions are taken largely from risk management perspectives, an understanding of the impact of fire on recreation values is also warranted.

There is, however, a paucity of studies in the literature that examine the impact of wildfire on recreation activities. The research that exists has found that recreation values are subject to change as a result of fire. Early work by Vaux et al. (1984) found that the recreational values were negatively affected by fire. Their results were derived using the contingent valuation method where recreationists assessed a change in their utility based on photographs of different fire impacted landscapes. Englin et al. (1996) used a discrete choice travel cost model to construct a linear inter-temporal damage function and found that recreation values decreased following a fire. Englin et al. (2001) have found that recreation value after a fire follows a highly non-linear inter-temporal path. In particular, they, among others (e.g. Hesseln et al. 2003), found that the year immediately following a fire generated increased visitation. They speculated this to be the result of the novelty of ecological attributes that follow a fire. They also found that the change in recreation values is heterogeneous across activity type and landscape

There have also been contingent valuation studies such as Loomis and Gonzalez-Caban (1997) that showed willingness to pay to reduce the fire risk in forest landscapes. Hesseln et al. (2003) found that demand for hiking in Colorado and Montana was affected differently depending on the type of fire impact on the landscape. In particular, they found that prescribed fire and wildfires have varying effects on recreation demand in forested landscapes. Furthermore, the scale of the fire impact on the forest landscape can also affect the value estimates. Although the results of existing research show inconsistencies (both positive and negative impacts) on how recreationists behave due to the effects of fire, they nonetheless show that wildfires impact recreation values.

2.6 Summary

The boreal forests cover 60% of Alberta's landmass and support numerous human activities, such as resource extraction and opportunities for outdoor recreation. These forests are also subject to wildfires which threaten these activities. The province, through the Forest Protection Program, is tasked to minimize the impacts of wildfires on various values-at-risk. Recreation values at present are not specifically included but are assumed to be reflected through the presence of publicly provided recreation infrastructure at a site. An explicit consideration of recreation values in allocating resources would be advantageous in that these values are closely linked to the presence of recreationists who are considered among the highest values at risk. Therefore, during fire events, directing resources to high valued recreation areas may fulfill a fire management goal of protecting highest values at risk, as well as identifying areas of the landscape where the suppression efforts are to be directed. Furthermore, since a majority of outdoor recreation occurs in forested landscapes, the significant value that generates must be accounted for in any forest fire management framework.

Figure 1. The forest protection area of Alberta

Source: Adapted from Alberta Sustainable Resource Development

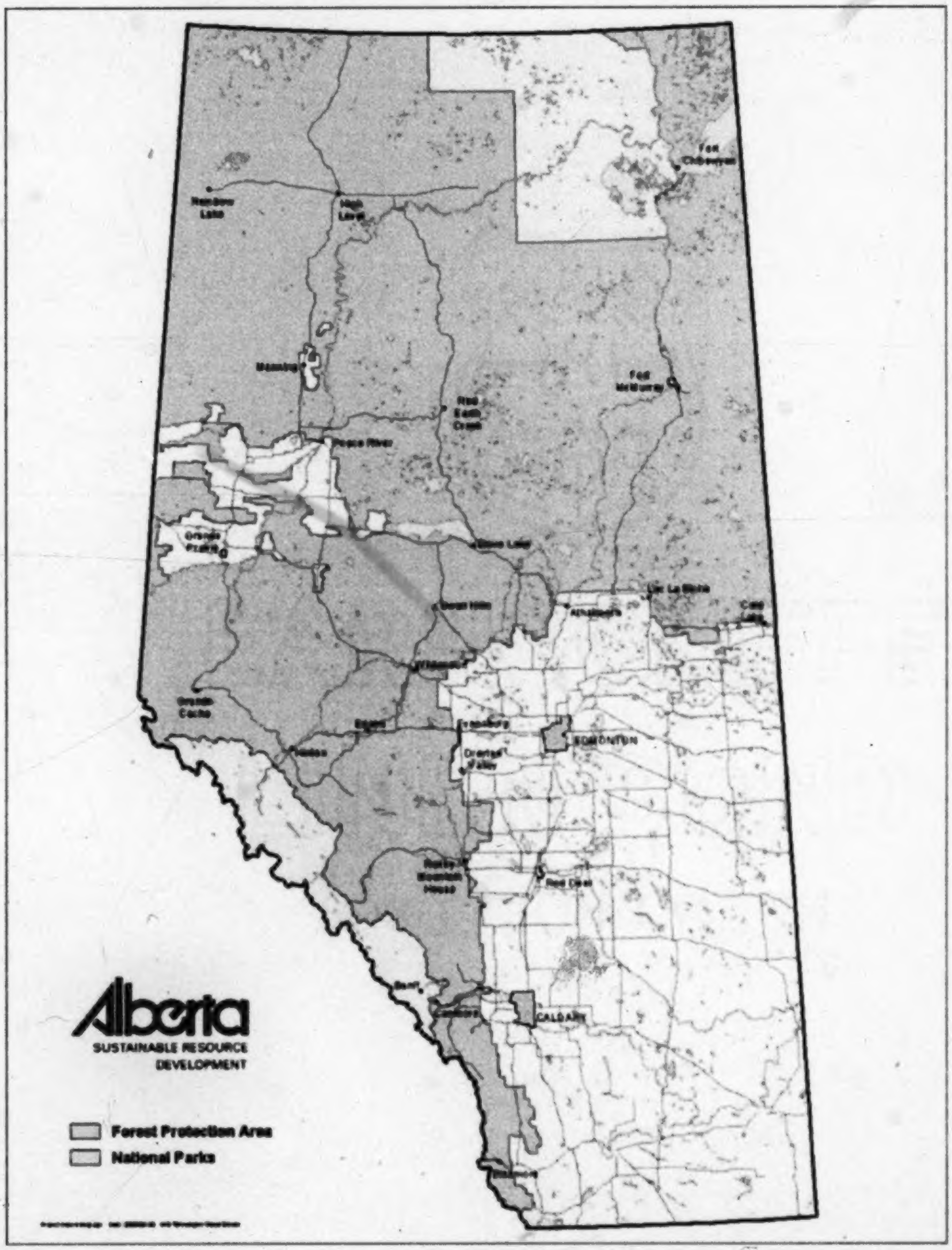
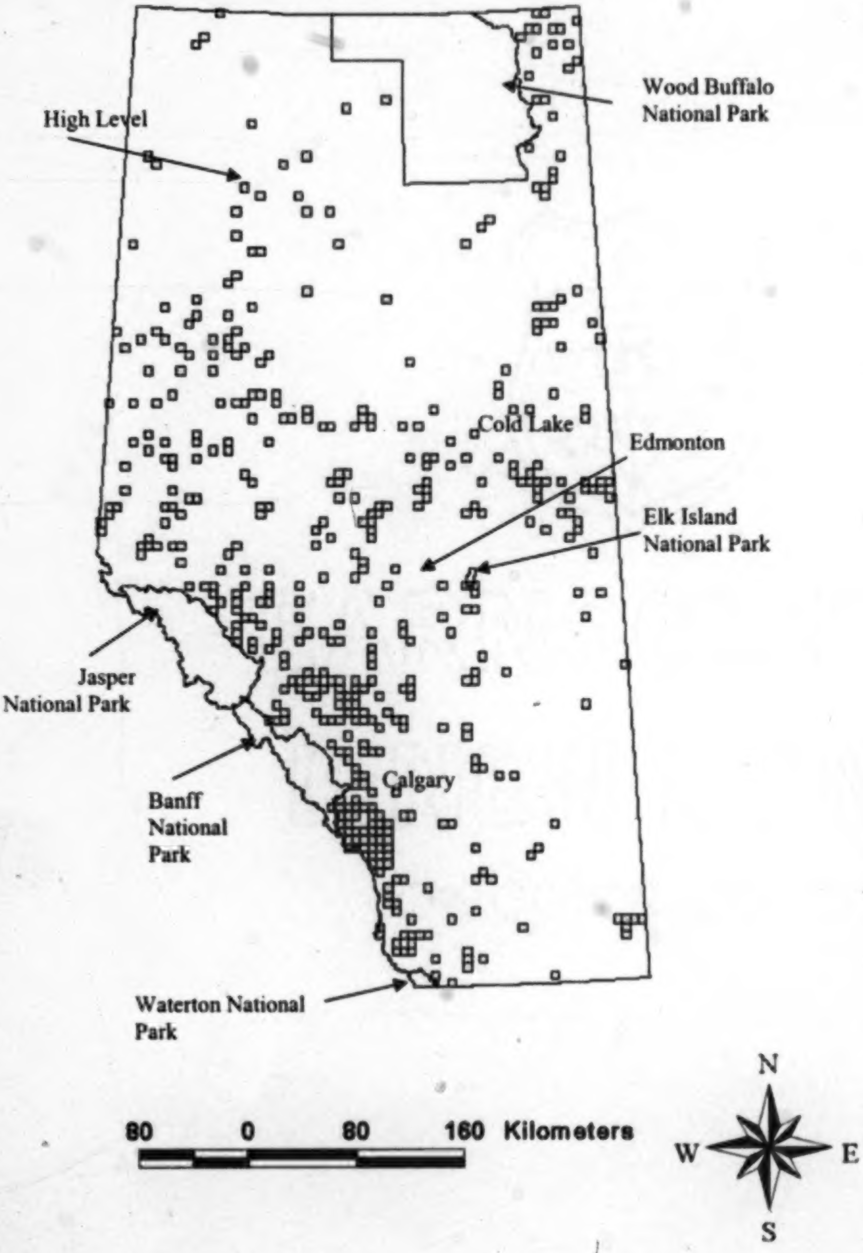

Fort Chipewyan
Rainbow Lake
High Level
Manning
Fort McMurray
Red Earth Creek
Peace River
Slave Lake
Grande Prairie
Lac La Biche
Swan Hills
Athabasca
Cold Lake
Whitecourt
Grande Cache
Edson
Evansburg
Hinton
EDMONTON
Drayton Valley
Rocky Mountain House
Red Deer
Banff
Canmore
CALGARY
Blairmore
Alberta
SUSTAINABLE RESOURCE
DEVELOPMENT
Forest Protection Area
National Parks

Figure 2. The spatial distribution of outdoor recreation infrastructure (provincial parks, recreation areas and campgrounds) displayed in 100 km^2 grids and outlines of the National Parks in Alberta.

Source: Sustainable Resource Development



High Level
Wood Buffalo National Park
Cold Lake
Edmonton
Elk Island National Park
Jasper National Park
Banff National Park
Calgary
Waterton National Park
80
0
80
160
Kilometers
N
W
E
S

Chapter 3
Recreation Management and Data Sources for Alberta

3.1 Introduction

Albertans derive significant value from participating in outdoor recreation activities. The National Survey on the Importance of Nature to Canadians (NSINC) found that in 1996, Alberta residents took 16.4 million trips to participate in a wide range of nature related activities which generated $1.2 billion in economic expenditures (Williamson et al. 2002). These activities also generated an annual estimate of consumer surplus of $ 220 million (FPT 2000). The significance of outdoor recreation in Alberta has also been shown by provincial studies such as Alberta Recreation Survey (2000) and Dobson and Thompson (1996). In particular, the latter study also estimated the economic impact to be over $1.0 billion. Given that forests cover substantial portion of Alberta, significant outdoor recreation activities can be expected to occur in that landscape. For example, Williamson et al. (2002) have found that nationally, approximately 86 % of outdoor recreation activities occurred in forested areas. Furthermore, 65 % of these activities occurred outside of designated parks and managed recreation areas. This suggests that an analysis of forest recreation use must also include forested areas not officially managed for recreation.

The spatial distribution of recreation trips across the province is not likely to be uniform. Particular recreation areas in the province, such as those found in the East Slopes Region, probably attract a large proportion of provincial recreation trips and thus are likely to be of higher value. Determining this spatial distribution of recreation activities has implications for values-at-risk in fire management. The purpose of this chapter is to review the availability of outdoor recreation data which can be used to construct a spatial picture of provincial recreation. Three data sources, encompassing national, provincial and local levels are investigated.

3.2 Recreation in Alberta

Major recreation regions in Alberta include Jasper and Banff National Parks, the Bow Valley corridor west of Calgary and some of the parks and recreation areas found throughout the province. Substantial recreation activities also occur in the public forest lands of the East Slopes Region. The importance of this Region is driven primarily by its location in the mountains and foothills and its proximity to the major population centres of Calgary and Edmonton. A variety of data sources on outdoor recreation activities exist at the national, provincial and local levels. However, differences in collection methods render much of that data unusable in a project of this nature. In particular, only some of the data sets explicitly incorporate the spatial distribution of recreation activity in a landscape. Despite these shortcomings, it is nevertheless instructive to examine these data in some detail.

3.2.1 The 1996 National Survey on the Importance of Nature to Canadians (NSINC)

NSINC is the result of joint effort of federal, provincial and territorial land management agencies to collect information on socio-economic information on the importance of nature to Canadians. The 1996 survey, conducted by Statistics Canada as part of the Labour Force Survey, was representative of approximately 98 % of the population 15 years of age or over (Statistics Canada and Environment Canada 1999).[1] The survey sampling methodology is state-of-the-art. This database currently comprises the most recent and comprehensive spatially explicit information on recreation in the province available. The survey incorporated statistical procedures that allow an analyst to develop estimates of total recreation use by the provincial population at sub-provincial levels (Statistics Canada and Environment Canada 1999). Unfortunately, the sampling protocols and the survey questions were not designed to be representative of the spatial distribution of recreation in the province. In particular, the survey asked the respondents the name of a human settlement closest in proximity to where the recreation activity took place. This resulted in limited geographic coverage of recreation activities since some areas of the province have few human settlements but contain numerous recreation destinations.

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[1] The survey is the fourth in the series that began in 1981.

Respondents to this survey also provided information on their levels of participation and their expenditure for the following categories of activities: general outdoor activities (e.g. camping, picnicking, off-road vehicle use), wildlife study (eg. bird watching), fishing and hunting[2]. The survey also solicited consumer surplus information from the respondents. Using the location information provided by the respondents, these activities can be mapped using a Geographic Information System (GIS) to provide the most recent levels of participation and their spatial distribution.

For each category of activity the survey asked respondents how many same day and overnight trips within Canada were taken[3]. A same day trip was defined as the number of times a respondent left his/her residence for a given activity and returned on the same day. While an overnight trip was defined as the number of times a respondent left his/her residence for a given activity and spent at least one night away from home (Statistics Canada and Environment Canada 1999). For example, the survey asked, "In 1996, did you take any same-day or overnight trips within Canada for which the main reason was to fish for recreation?" If the response was "yes", the respondent was directed to the section pertaining to fishing. The responses that were valid skips were coded as "996" while missing response was coded as "999". The lowest and highest allowable values for trips were 0 and 995 respectively. The consumer surplus was derived by asking respondents how much additional expense they would be willing to incur before deciding to forego recreational activities.

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[2] All amounts are listed in 1996 dollars

[3] Note that the survey also solicited information on recreation user days. However, trip was chosen as the unit of analysis.

There are several attractive features in using the NSINC data. First, the response rate was relatively high, around 70%.[4] Second, the data are collected from randomly drawn sections of the general population, and thus avoid some of the issues such as truncation and endogenous stratification associated with on-site sampling as outlined by Ovaskainen et al. (2001). Truncation refers to the fact that in onsite sampling, the individual sampled must have taken at least one trip. Thus, the number of trips per individual surveyed is truncated at the zero level. Endogenous stratification occurs because frequent visitors are more likely to be sampled than occasional visitors. Due to these issues there is a concern in inferring results from onsite sampling to the general population.[5] Given the method of data collection used in NSINC, some results can be applied to the general population.

The Alberta portion of the national sample included 1,885 individuals taking 16,965 trips during 1996.[6] A majority of these trips were day trips, with trips taken for outdoor activities accounting for about two thirds of the total trips taken (Figures 1 and 2). The spatial distribution of the trips showed that a majority of the sample trips (88%)

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[4] Higher response rate implies that inferences regarding the population are less likely to be biased

[5] There are methods that are used to correct for these issues but have some restrictive properties associated with them as outlined by Ovaskainen et al. (2001).

[6] Only the trips taken by Alberta residents to Alberta destinations were included. Trips taken to National Parks were excluded.

occurred in southern Alberta (Figure 3)[7]. Table 1 shows that the sample, when inflated to the provincial level resulted in 16.4 million trips with outdoor activities accounting for majority of the trips taken (FPT 2000)[8]. Trips taken for wildlife viewing, fishing and hunting were 5, 4.5 and 1.1 million trips respectively (Table 1).

The consumer surplus values for these activities, derived from the NSINC, ranged from $10 to $19 per trip with the weighted average value of $21 per trip (Table 1). However, accounting for the north and south areas separately caused an adjustment to the weighted consumer surplus and trip inflation factors. The surplus values were $21 and $19 per trip while the trip inflation factors were 764 and 464 for the north and south respectively (Table 2).

However, a limitation in this data is that it assumes recreation site choice to be associated with human settlement. This limitation is especially evident in the East Slopes Region where despite being highly sought for recreational activities, the spatial distribution of those activities were restricted to settlements such as Jasper and Banff. Despite this limitation, NSINC does provide some broad indication of spatial distribution of recreation activity in the province and this data will be heavily used in an exploratory attempt to understand the spatial nature of recreation in the province.

3.2.2 Provincial Data Sources

The provincial government also collects recreation data largely from visitors to the network of parks and recreation areas under its jurisdiction. Sources of these data include the visitation statistics prepared by the Parks and Protected Areas Division of the Alberta Community Development. The Division also conducts periodic Camper

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[7] Southern Alberta is defined as the area south of Cold Lake.

[8] The inflation factor, 739, was derived by dividing the total number of trips taken in Alberta by the total trips in the sample.

Satisfaction Surveys in a sample of areas under its jurisdiction (Finzel 2003). However, changes in administrative responsibilities and policies have resulted in gaps in data collection. Despite these limitations, it is still instructive to examine this data in some detail.

Alberta's parks and protected areas network covers roughly 27,500 km^2 and include more that 500 sites (Alberta Community Development 2004). There were 8.7 million visits made to Alberta provincial parks and recreation areas in 2000/2001 (Alberta Community Development 2001). Figures 4 and 5 show the top 10 sites for the overnight and same day visits to Alberta parks and recreation areas (Alberta Community Development 2001). A majority of these sites are located in close proximity to the mountains or major population centres such as Edmonton and Calgary. An uneven spatial distribution of visits to Alberta parks is shown by the fact that 45% of the overnight visits and 75% of the same day visits occur in the 10 sites for each of the visitation categories (Alberta Community Development 2001).

Another source of information is the Alberta Recreation Survey. The latest survey, conducted in 2000, solicited responses from randomly selected Alberta households. It found that Albertans are engaged in a variety of outdoor recreation activities such as camping, wildlife viewing, hunting and fishing. The survey incorporated spatial consideration of those activities by asking respondents the location of parks and recreation areas they visited. The survey also asked the respondents' preference for camping outside of the network of parks and protected areas. In doing this, the survey attempted to solicit some information on random camping activities in the province. Results indicated that outdoor recreation activities such as camping, fishing and hiking were among the favourite activities of Albertans.

There are limitations to using these provincial data sets to develop a values-at-risk-map (VARM) for fire managers. They include a lack of consumer surplus measures associated with recreation activity and inadequacy of spatial consideration of recreation activity on the landscape. They also largely ignore recreation that occurs in areas that are not formally designated as parks and recreation areas.

3.2.3 East Slopes Region Random Recreation

The East Slopes Region of Alberta is commonly defined as being the mountains and foothills that form the 'Eastern Slopes' along the Rocky Mountains that straddle the Alberta-BC border and typically excludes the National Parks. This Region extends from the United States border in the south to the Peace River Region, north of Jasper National Park. However, there is no political boundary that delineates the East Slopes Region.

The East Slopes Region offers many opportunities for outdoor recreation. Some of the highly sought recreation areas include Kananaskis Country west of Calgary and the network of parks and recreation areas. These opportunities are further expanded by the presence of forestry roads in some parts of this region which offer access to many backcountry areas. The importance of accounting for recreation in areas not formally designated as recreation or protected areas was highlighted by Williamson et al. (2002) who found that the majority of outdoor recreation activities in forested landscapes in Canada occurred outside of such areas. This activity is often called random camping in Alberta and this activity is characterized by camping at unmanaged sites on public lands, a lack of amenities, and where no camping fees are charged (McFarlane et al. 2003).

Interviews with local land management personnel in the East Slopes Region revealed that substantial random camping activity occurs throughout the Region. This suggests that random camping activities should be accounted for when examining the extent of recreation activity on a landscape.

Despite this evidence, there have been relatively few studies conducted in this region that have explicitly included random camping. Past studies (McFarlane et al. 2003; McFarlane et al. 1996) have found random camping to be wide spread in some parts of the East Slopes Region. These studies gathered random camping information by explicitly asking the respondents how many random camping trips they took to the study area. The lowest value recorded was 0 trips while the highest value was greater than 20 trips. These research in the Rocky-Clearwater area, south-west of Edmonton, have indicated that the extent of recreation activity occurring as random camping has increased over time. McFarlane et al. (2003) found that the random campers preferred rustic facilities and services and were more tolerant of industrial activity than campers in the provincial parks and recreation areas. This maybe related to the fact that this activity offers numerous opportunities for random campers to engage in motorized recreation using all terrain vehicles. Other studies conducted in this region, such as McFarlane and Boxall (1998), while providing some estimates of recreation use, are largely based on activities occurring in an established network of parks and recreation areas.

The relative paucity of studies on recreation intensity and value in the province is not surprising given that currently there is no systematic method of collecting recreation use data. In the past, Alberta Land and Forest Service managed and collected recreation use data, including random camping data that occurred in the public forest land.

However, changes in administrative responsibilities and policies since then have meant that much of this data is currently not collected. Some local offices in the East Slopes Region collect some data but an ad hoc nature of data collection limits its use. The most up to date data source available is the result of patrols conducted by Forest Officers and Guardians. The patrols give these individuals insights into the extent of recreation activities that are occurring in the landscape. This knowledge is particularly important since these patrols often include areas outside of established parks and recreation sites. While this knowledge is not formally collected, the officers are valuable sources of information on the extent of recreation activities occurring in the East Slopes Region. This knowledge is also useful in that spatial distribution of recreation activity can be determined particularly since the NSINC data contains notable gaps in this Region.

3.3 Constructing a Spatial Picture of Provincial Recreation

The spatial distribution of outdoor recreation infrastructure in the province suggests that southern Alberta has greater opportunities for outdoor recreation. These opportunities are exhibited in 100 km^2 grids in Figure 6. Furthermore, in constructing a spatial picture of provincial recreation, one must account for the fact that the locations of recreation trips in the NSINC database were normally specified according to proximity to human settlements, parks and other infrastructure. This geo-reference probably contains error in location. This, and the fact that spatial information about the recreation locales was required to determine what influenced the level of activity and to predict future recreation use, resulted in the development of spatial units. The choice of the spatial unit rather than using the specific "point" location allowed some consideration of the error in location as well as the development of indicators of relative attractiveness of the units for recreation.

The spatial unit can be specified using a variety of methods including, among others, buffering (Hunt et al. 2004), using administrative areas (Monchuk and Miranowski 2003) or constructing geometric areas (Bateman and Lovett 2000; Bateman et al. 1999). This typically involves hexagon tessellation. A review of literature, however, found that most spatial recreation studies have used grid or regular tessellation (Bateman and Lovett 2000; Bateman et al.1999). Hence this form of spatial unit was chosen to examine spatial recreation use in this study. Further impetus for selecting grid tessellation came from SRD as well. Thus, the spatial unit of analysis throughout this study was defined in equal area cells on a regular lattice.

Of the data sources examined, the NSINC provided the most consistent and recent economic value and spatial distribution of outdoor recreation trips for the entire province. The various available databases from the East Slopes Region, while spatially explicit, generally lack detailed information on the economic values associated with those trips and are only for localized study areas. A cursory examination of the NSINC data in Figure 3 showed that the spatial distribution of recreation activity (and implicitly recreation value) is not necessarily tied to the presence of recreation infrastructure in Figure 6. This distribution has implications for fire managers, as they currently prioritize fire events based on various values at risk.

3.4 Summary

Albertans derive significant value from outdoor recreation activities. The national, provincial and local data while not comparable with each other do indicate the presence of substantial recreation activities in the province. In particular, a majority of the recreation activity occurs in the southern part of the province with major concentration along the East Slopes Region. A cursory examination of the spatial distribution of recreation activity and infrastructure suggests that activity is not necessarily tied to infrastructure. This has implications for fire managers as they prioritize fire events based on various values at risk. The data requirements for this project are such that spatially explicit recreation data and associated consumer values are required. These considerations led to the use of NSINC and random camping data sets.

Table 1. Numbers of trips taken for outdoor recreation activities and associated consumer surplus values for Albertans in 1996.

	Activity				
	Outdoor	Viewing	Fishing	Hunting	Total
Participants	1079000	397000	361000	84000	1921000*
Trips	11959000	5092000	4419000	1114000	164000000*
CS/trip ($)	13.77	9.81	16.58	19.07	21.43**
Trips/participant	11.08	12.82	12.24	13.26	8.53**

* These estimates include wildlife viewing, fishing and hunting as main and secondary activities combined. As a result, the total values are less than the sum of the individual activities.

** These are weighted averages.

Source: (FPT 2000:35)

Table 2. Consumer surplus values and trip inflation factors associated with outdoor recreation trips for the northern and southern regions of Alberta in 1996.

	North	South
Total trips	13.2 million *(0.12) = 1.58 million	13.2 million * (0.88) = 11.62 million
Trip inflation factor	764	484
Trips/participant	8.53	8.53
CS/trip ($)	19	21

Figure 1. Distribution of outdoor recreation trip type in Alberta in 1996.

Source: Statistics Canada and Environment Canada (1999)

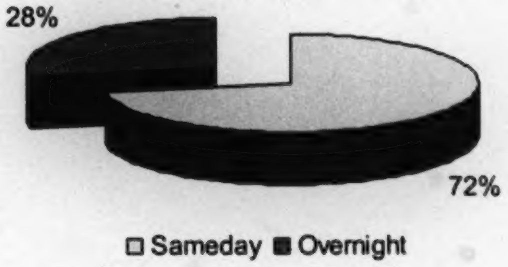


Figure 2. Distribution of outdoor recreation activities in Alberta in 1996

Source: Duwors et al. (1999)

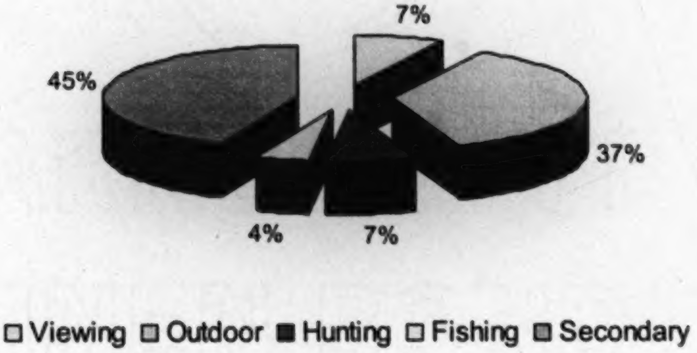


Figure 3. The spatial distribution of recreation trips taken to 100 km^2 cells. Each coloured cell indicates at least one trip taken by Albertans in the province during 1996.

Source: Statistics Canada and Environment Canada 1999; Sustainable Resource Development

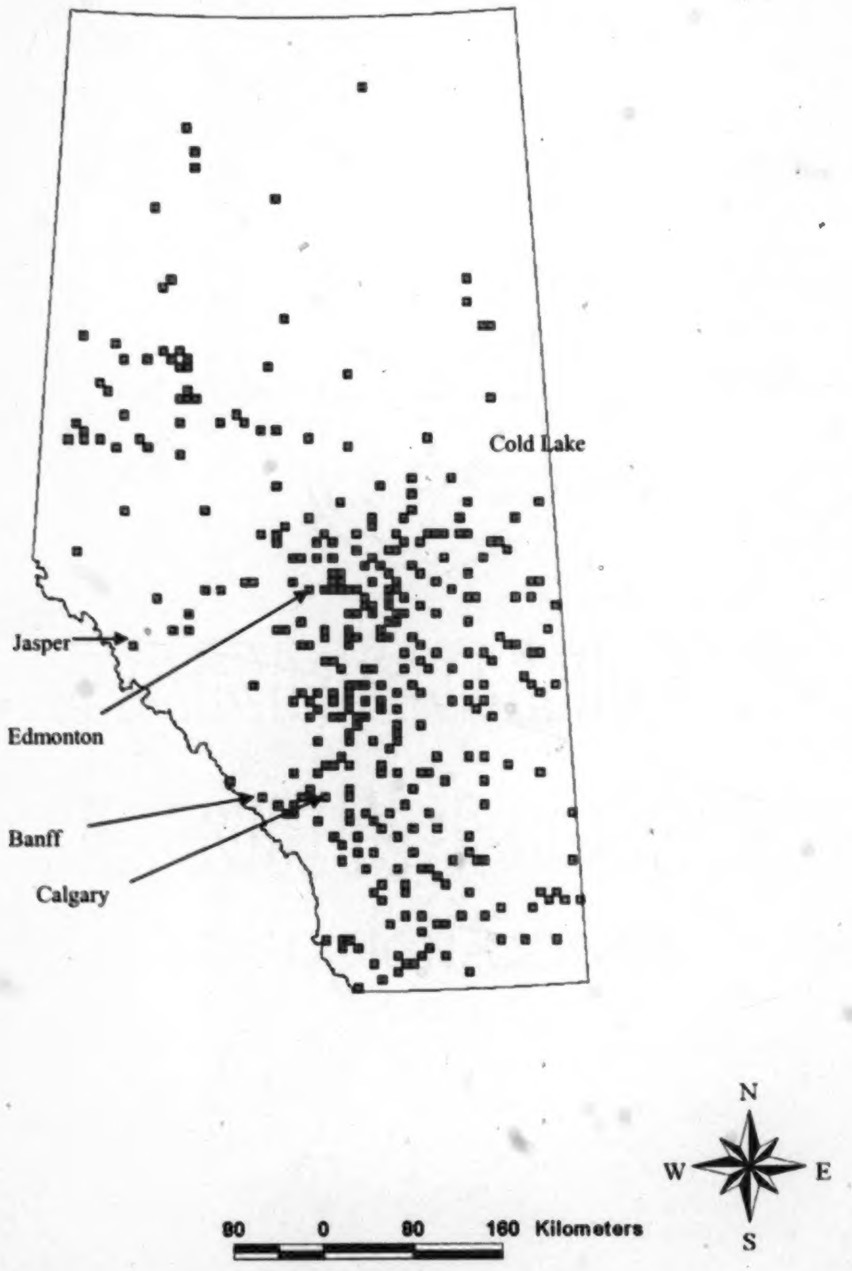

Cold Lake
Jasper
Edmonton
Banff
Calgary
N
W
E
S
80
0
80
160
Kilometers

Figure 4. The ten most visited Alberta provincial parks and recreation areas for overnight visits in during 2000/2001.
Source: Alberta Community Development (2001)

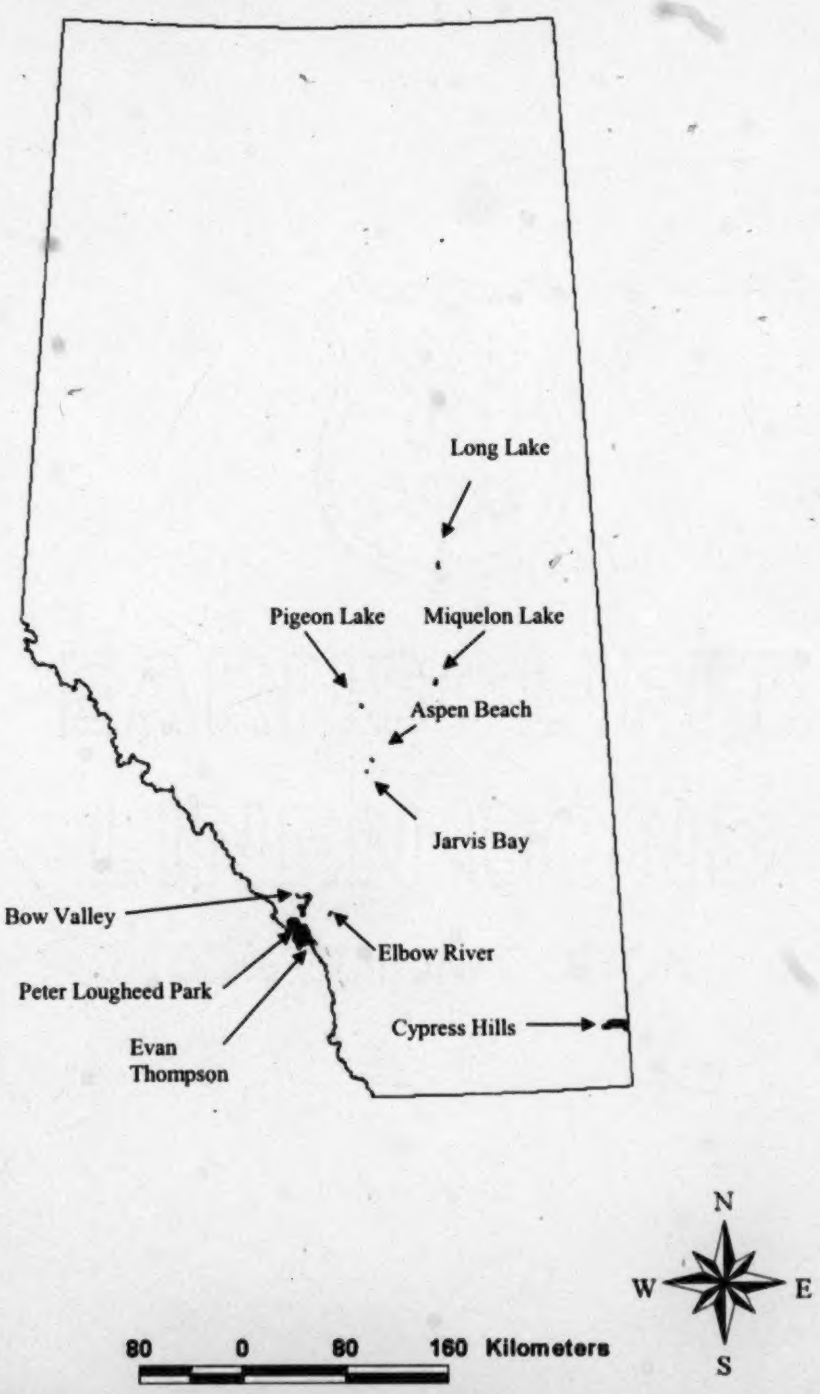

Long Lake
Pigeon Lake
Miquelon Lake
Aspen Beach
Jarvis Bay
Bow Valley
Elbow River
Peter Lougheed Park
Cypress Hills
Evan Thompson
N
W
E
S
80 0 80 160 Kilometers

Figure 5. The ten most visited Alberta provincial parks and recreation areas for same day visits during 2000/2001.
Source: Alberta Community Development (2001)

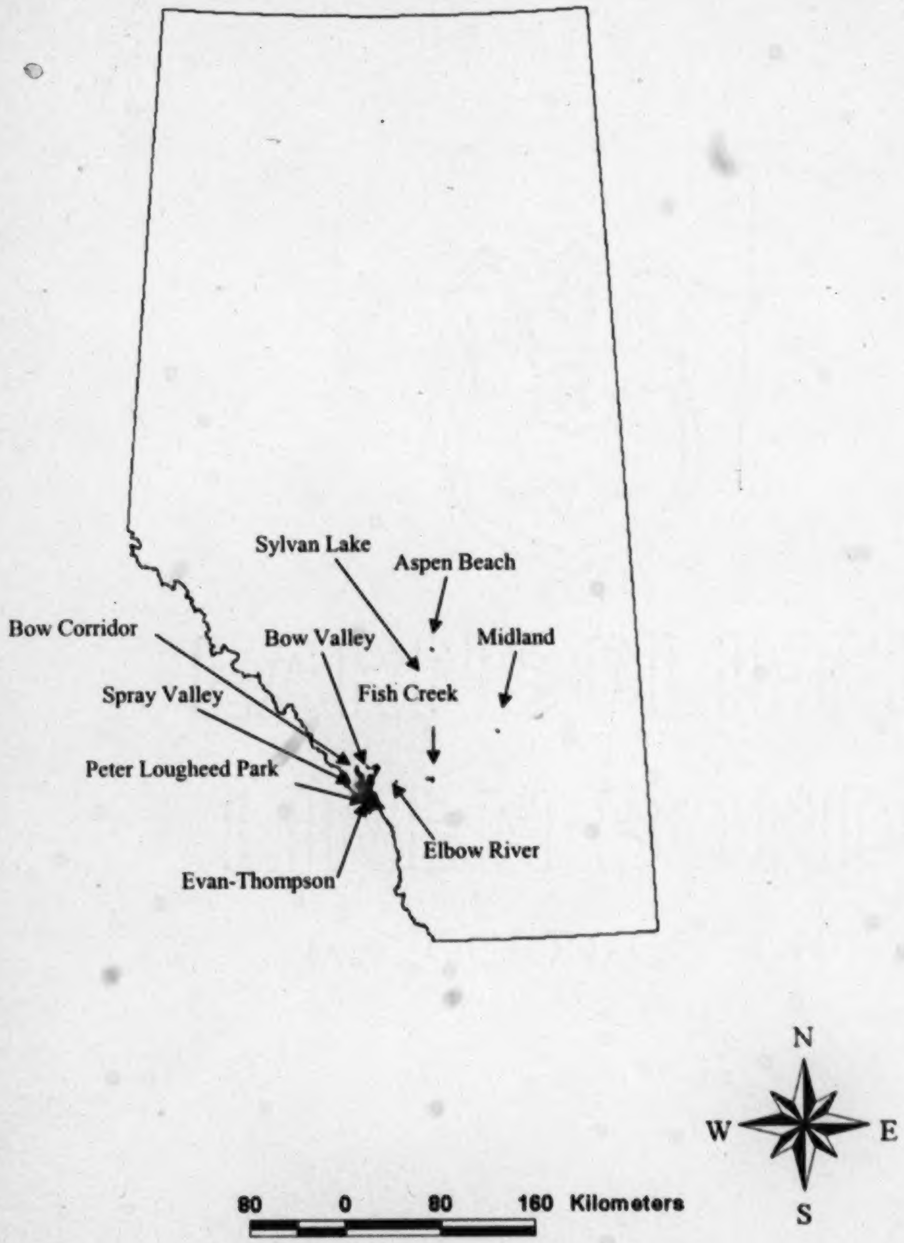
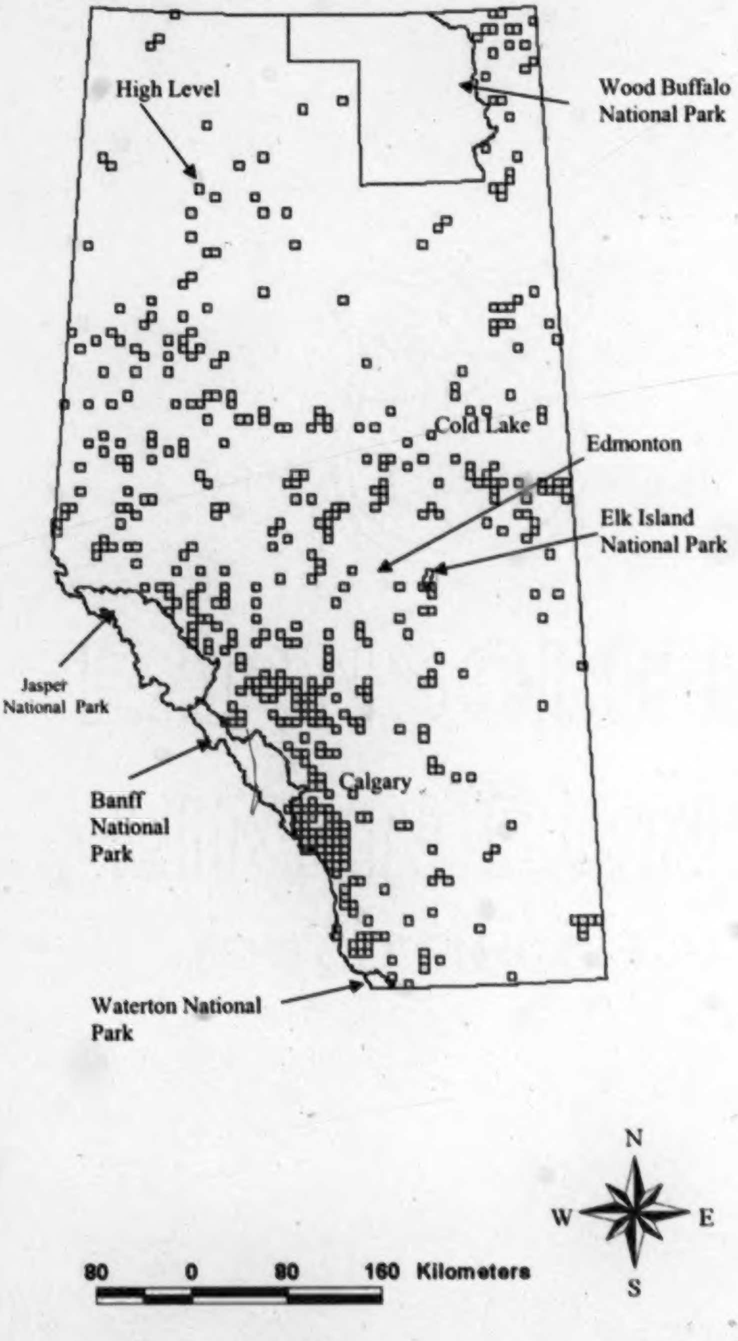

Sylvan Lake
Aspen Beach
Bow Corridor
Bow Valley
Midland
Spray Valley
Fish Creek
Peter Lougheed Park
Elbow River
Evan-Thompson
N
W
E
S
80 0 80 160 Kilometers

Figure 6. The spatial distribution of outdoor recreation infrastructure in 100 km^2 cells in Alberta

Source: Sustainable Resource Development


High Level
Wood Buffalo National Park
Cold Lake
Edmonton
Elk Island National Park
Jasper National Park
Banff National Park
Calgary
Waterton National Park
N
W
E
S
80
0
80
160 Kilometers

Chapter 4
A Provincial Picture of Recreation Values at Risk

4.1 Introduction

The importance of outdoor recreation in Alberta was outlined in Chapters 1 and 3. Some highlights included the fact that in 1996, 1.5 million Albertans took 13.2 million trips for outdoor recreation activities and that much of these activities occurred in southern Alberta contained. Chapter 2 provided an overview of how incorporating recreation values can enhance Alberta's values at risk framework for fire management. Some highlights follow. That framework considers human life, and implicitly recreationists, to be the highest values at risk from wildfires. For fire management agencies that strive to suppress all wildfires this issue is particularly challenging when faced with fire suppression resource constraints. Therefore, during fire events, directing resources to high value recreation areas fulfill a fire management goal of protecting highest values at risk, as well as identifying areas of the landscape where the suppression efforts are to be directed.

There are multiple criteria in determining the value of recreation site. Chapter 2 noted that current fire management policy uses the replacement costs or "value" of recreation infrastructure at a site. However, Chapter 3 showed that the recreation activity is not necessarily tied to infrastructure. Furthermore, it was also noted that a majority of recreation activity occurring in parks and recreation areas tends to occur in relatively few sites. This evidence raises the question as to how much resources should be allocated to sites where there are few, if any, recreation activities.

Another criterion is to examine the value associated with participating in the activity, and this may be or may not be associated with recreation infrastructure. This requires the development of spatially explicit indicators of forest recreation be incorporated into a fire management zoning scheme or values at risk map (VARM). The advantage of using this criterion has already been outlined above. Thus, the purpose of this chapter is to develop a recreation values at risk map for the province of Alberta by analyzing outdoor recreation demand.

Research has shown that recreation demand and supply is most appropriately studied under household production function framework (Batie et al. 1976; Bockstael and McConnell 1981). Further, recreation trip is the most appropriate measurement unit for recreation demand analyses (Cordell and Bergstorm 1991). However, these trips are not traded in traditional economic market. Following Lancasterian theory, a household's decision-making process can be divided into production and consumption stages. This theory states that a household in production stage uses inputs such as time, skills and knowledge to produce a given level of output at least cost combination while in the consumption stage the household determines the levels of produced commodities so as to maximize utility subject to its budget constraint (Batie et al. 1976). Essentially, in this model supply and demand for recreation trips are determined from a household perspective. That supply is represented by projected trends in trip production and consumption in the future, given expected constraints on resources available for recreation (Cordell and Bergstorm 1991). Demand is measured by the number of trips households would take if resource availabilities are unconstrained and if the future trip cost remains unchanged. In order to satisfy constant trip cost, it is assumed that recreation opportunities adjust as necessary and unconstrained to meet changes in use and population (English et al. 1993).

Harrington (1987) showed the inadequacy of commonly used measures of recreation resources, such as facilities per capita or raw facility counts. A superior concept was outlined in English and Cordell (1993) who constructed an effective recreation opportunity set (EROS) index to measure availability of recreation opportunities and this can be used in models of household production framework. EROS, when combined with demand, results in recreation participation. The underlying theory is that individuals look at the spectrum of recreational opportunities and make an active decision with respect to participation. Traditionally, demographic and socioeconomic characteristics have been used in recreation demand analysis. Examples can be found in Rockel and Kealy (1991), Bergstorm and Cordell (1991), Hay and McConnell (1984). However, some researchers have taken advantage of the spatial nature of outdoor recreation data and modeled recreation demand as a function of biophysical attributes of the landscape (Brainard et al. 1999; 2001). These specifications, although lacking in traditional demand variables, have found to be robust at predicting recreation demand. Typically, these specifications use the levels of human population in the surrounding landscape. The population variable may capture some of the attributes associated with the travel cost variable found in traditional recreation demand analysis. Specifically, population that were further away from recreation sites displayed decreased visitations.

In this research we also modeled recreation visitation levels as a function of available infrastructure and other site-specific attributes of the landscape. Thus, the spatial nature of recreation data was explicitly examined by modeling visits to an area as a function of the spatial pattern of biophysical attributes of the site and of the surrounding sites. Given the underlying data structure, econometric procedures to estimate the levels of recreation use in a spatial manner across the province were employed.

Prior to examination it is expected that much of the recreation activity occurs in southern Alberta particularly in the East Slopes Region. Relatively few recreation activities were expected to occur in the northern portions of the province due to the low levels of resident human population and the high costs of travelling there from the south.

4.2 Data

Examining recreation participation in the province in a spatial economic manner is a challenging task. Many recreation trips (e.g. random camping) take place on lands that are not subject to spatially referenced permits or registrations as would be found at campgrounds or parks. Furthermore, databases of registrations and permits that arise from government or private camping operations are not currently constructed or collected in a consistent manner which prevents their use in a project of this nature. The only spatially referenced recreation data available was obtained from the 1996 National Survey on the Importance of Nature to Canadians (NSINC).

The Alberta portion of the data was extracted from the national database. Further details on this data are provided in Chapter 3. The respondents provided consumer surplus values for a variety of outdoor recreation activities and the names of the nearest human settlement to which those activities occurred. A map of these 1996 data is presented as 100 km^2 cells to provide an initial spatial distribution of recreation activity in Alberta in 1996 (Figure 1).

4.2.1 *Spatial Considerations*

Some details on spatial considerations are provided in Chapter 3. Recall that the NSINC survey asked respondents to name of the nearest human settlement to which they participated in same day or overnight recreation activities. This geo-reference probably contains error in location. The choice of the regular tessellation (100 km^2 cells in a regular lattice) to represent the location of a trip rather than using the specific "point" location allowed some consideration of the error in location. This choice of spatial unit also allowed the development of indicators of relative attractiveness of the units for recreation. While there are a variety of methods of specifying the spatial unit, a review of the sparse spatial recreation literature found this approach to be an accepted method.

The selection of cell size was motivated by several factors. A review of literature provided no definitive guidance on the issue other than to caution researchers to use a cell size appropriate to the specific research (Kuo et al. 1999; Harrison and Dunn 1993). Previous recreation demand studies experimented with varying cell sizes such as 0.25 km^2 (Brainard et al. 1999), 1 km^2 (Bateman et al. 1996) and 25 km^2 (Bateman and Lovett 2000). Harrison and Dunn (1993) showed that there are substantial gains to be had, in terms of consistency of the results, in moving to a smaller unit of spatial analysis. Bateman et al. (1999) investigated this issue further and found that additional detail afforded by using finer cell sizes must be balanced with the large increase in computing time. These findings suggested that cell size choice is a function of the research being conducted.

In this study two cell sizes were initially examined in preliminary experimentation, a 25 km^2 cell size which resulted in 26,516 cells covering the province, and a 100 km^2 cell size which yielded 6,618 cells for the province. Query analysis in ArcView showed that the 25 km^2 cell size resulted in 361 cells that contained at least one trip location, while the 100 km^2 cell size had 341 cells that contained at least one trip location. However, the more even distribution of the data in the 25 km^2 configuration must be balanced with the significantly less computational time requirement for the 100 km^2 configuration in conducting analysis. Furthermore, the data in the 25 km^2 grid was only marginally better distributed than the 100 km^2 grid. This distribution has an impact on the specification of neighbours and thus the sample size as shall be shown in 4.3.1.

An additional factor in choosing the cell size was the distance consideration. Since a majority of the recreationists were assumed to use motorized vehicles, it is reasonable to assume that the choice of 100 km^2 cells can be considered within a recreationists' choice of site. For these reasons, a 100 km^2 cell size was chosen as the spatial unit of analysis in this component of the study.

4.2.2 Landscape Attributes

Staff at the Alberta Department of Sustainable Resource Development (SRD) provided landscape attribute data for the province in a Geographic Information System (GIS) format. This data contained layers of landscape features such as road networks, hydrological features, human settlements, forest cover and fire history. Some of the hydrological features exhibited a significant degree of collinearity and were dropped from the analysis. The remaining polygonal water features were aggregated and their areas converted to shoreline lengths. This aggregation was thought to provide a suitable indicator of recreation attractiveness as shoreline length likely captures access to water bodies better than measures of polygonal features.

The human settlement layer consisted of large cities to small villages and was associated with the most recent provincial census. This information was used to determine if human population levels in proximity to a cell had an influence on the levels of recreation in that cell. The 1996 NSINC data contained information on the one-way distances travelled by each respondent. A variety of these distances from each cell centroid were buffered and population levels within those buffers were estimated. Note however, that the population levels from neighbouring provinces and states next to Alberta's boundaries were excluded from these buffers even if they were within these distances. Based on preliminary model estimations the population levels that were within 70 km and 120 km buffers were used as explanatory variables in explaining trip levels.[1]. In the preliminary estimations, the low level of statistical significance for fire history led to this variable being dropped from the final regression models discussed below.[2]

4.3 Econometric Modelling

Traditional recreation demand specifications typically include price (in the form of travel costs), income, substitute prices and individual specific characteristics. However, some cases recreation demand models have departed from the individual decision maker acting in isolation to an explicit accounting of that individual's interaction with other factors relating more to the recreation environment or setting (e.g. Brainard et al. 1999; 2001). In this study we use the insights of Brainard et al. (1999; 2001) to specify a reduced form demand equation in which a number of traditional demand variables are omitted or proxied. In this framework the spatial unit forms the unit of analysis and demand for trips to these units are largely a function of the attributes of those units. The following equation specifies this relation:

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[1] These distances were chosen by considering past literature (McFarlane et al. 1996) who found that recreationists generally live within 1 to 2 hour drive from a recreation site. In addition, various diagnostic tools such as the significance of coefficient, the log likelihood function and adjusted R^2 were used to in selecting those distances.

[2] This may stem from poor available data. We only had access to data for E-class fires; these fires are those that reach over 200 hectares in size.

$$Y_j = \alpha + \beta X_j + \varepsilon \quad (1a)$$

where Y is the number of trips observed in a year to spatial unit j, X is a vector of attributes for j, α and β are parameters to be estimated, and ε is an error term.

When choosing an econometric model to estimate the parameters in equation 1a several factors must be considered. These include econometric theory, available methods, some knowledge of the underlying data structure and some knowledge of the expected results. In particular, preliminary examination of the data revealed the presence of many censored[3] observations in northern Alberta and relatively few in southern Alberta. This led to the consideration of spatial ordinary least squares (SOLS) and Tobit as the two model specifications. These models were applied to the grid cell map of the province in order to understand the influences of a cell characteristics and cell neighbours on recreation trips in a given cell. Tables 1a and 1b provide a description of the final set of dependent and independent variables used in the regression analysis for north and south respectively and their associated descriptive statistics.

The expectations of the signs on the parameter estimates associated with these variables were as follows. The water access variable was expected to be positive as recreationists are likely to be drawn to cells with water bodies for recreation. This is probably more pronounced in the south where there are relatively few water bodies than the north. The quadratic parameter associated with water availability was expected to be negative. This implies that increased water availability eventually leads to decline in the numbers of trips taken to a cell. A similar result can be expected for the road variable as it offers access for recreation. However, crowding and congestion from increasing access levels would be expected to generate a negative quadratic parameter estimate for the variable. The forest variable was also expected to be positive as suggested by other recreation studies such as (Brainard et al. 2001; Bateman and Lovett 2000). The campground variable was expected to be positive as was the variable capturing settlements in the Mountain Region since they provide the recreationists with amenities such as campgrounds, hiking trails, outfitting services, and other accommodations. The population variable is expected to be significant as suggested by other recreation studies such as (Brainard et al. 2001; Bateman and Lovett 2000).

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[3] Censored data refers to cases where observations are recorded only as above or below some threshold

4.3.1 Spatial OLS (SOLS)

Spatial econometrics deals with the estimation and specification of problems that arise from spatial autocorrelation in cross-sectional data (Anselin and Bera 1998). Those problems can be attributed to either structural relationships among the observations (lagged dependency) or the spatial dependency among the error terms as a result of the omission of correlated explanatory variables (Hunt et al. 2004). Researchers have shown the importance of accounting for spatial relationships in fields such as hedonic applications (Can 1990; Pace and LeSage 2002) and technological adoption (Case 1992; Dubin 1995). This interest in spatial econometrics can largely be attributed advances in techniques such as GIS that can handle data from a practical perspective.

Anselin (1988) suggested that spatial relationships like equation 1a should be reformulated as follows to capture both possible spatial dependencies described above:

$$Y = \alpha + \rho W_1 Y + \beta X + \varepsilon \quad \text{(1b)}$$

where the spatial unit identifier has been suppressed for convenience. In this equation $\varepsilon = \lambda W_2 + \mu$, with $\mu \sim N(0,\Omega)$. The model includes, W_1, the spatial weights matrix, a coefficient for the spatially lagged variable (ρ), a possibly different spatial weights matrix (W_2), and a coefficient (λ) for the spatial autoregressive structure for the disturbance (ε). Additionally, α and β (a vector) are parameters to be estimated. Y is a vector of dependent variables and Y is also the same vector of the dependent variable which is multiplied by the spatial weights matrix, W, and X is a matrix of independent variables. A non-zero λ represents spatial error which leads to unbiased yet inefficient statistical inferences while a non-zero ρ value represents a spatial lag which leads to biased and inconsistent statistical inferences if estimated using ordinary least squares (OLS) (Anselin 1988).

A challenge using these techniques is the specification of the spatial relationship among n observations which is captured by the weight matrix, W, with n x n dimensions. This matrix is characterized by zeros along the main diagonal and has off diagonal elements representing the influential neighbours. These neighbours can be specified using a variety of methods including distance based criteria (Anselin 1988; Acs et al. 2002) and contiguity measures (Anselin 1988; Pace and Lesage 2002). For this study a 1st order geographic contiguity (queen configuration) weights matrix with a value of 1.0 for neighbours was employed. This spatial configuration essentially involved consideration of the effects of the eight neighbours that are connected to a cell which has a human settlement in it. This choice of a weights matrix resulted in a sample size of 3531 grid cells (Figure 2). Figure 3 provides an illustration of this configuration.

4.3.1.1 Testing for Spatial Dependencies

A method to estimate jointly the spatial lag and the spatial error is currently unavailable (Hunt et al. 2004). As such, a researcher must select a spatial autoregressive model by testing for ρ or λ through several tests based from the unrestricted, OLS, model ($\rho = 0$, $\lambda = 0$). These tests could suggest that both the spatial lag and error model are appropriate (ibid). However, if using Lagrange Multiplier (LM) tests, the preferred model will have the higher χ^2 (Anselin and Rey 1991). These models are typically estimated using maximum likelihood procedures, but other approaches are possible. Despite the wide array of estimation methods available, research has suggested that parameter estimates are likely to be impacted more by the choice of a spatial weights matrix than by the chosen estimation technique (Bell and Bockstael 2000).

4.3.2 Tobit

The Tobit model belongs to a class of models that seek to solve the problem of estimating coefficients in regressions with a limited dependent variable. Such a variable can be defined as a variable having a lower or upper limit which takes on a limit value for a substantial numbers of observations. However, that variable can take on a wide range of values above or below the limit for the remaining observations (Norris 1985). In this study, the dependent variable, the number of trips to a cell, has a lower limit of 0 and can take on values over a wide range above the limit. This type of data where some observations are recorded only as above or below some limit value is said to be censored (Greene 2000).

The Tobit model is often employed in estimating censored at zero distribution of data under the assumption of normality of errors (Greene 2000). The Tobit is preferable to OLS in these instances because the Tobit model allows for the inclusion of observations with zero trips. OLS estimation based on a censored data is likely to lead to inconsistent estimates (Norris 1985).

A Tobit model can be represented as:

$$Y = \beta X_c + \varepsilon \text{ if } \beta X_c + \varepsilon > 0 \qquad (2a)$$

$$Y = 0 \text{ if } \beta X + \varepsilon \leq 0 \qquad (2b)$$

Where, Y is the vector of observed dependent variable, β is vector of parameters to be estimated, X is the matrix of explanatory variables and includes the site attributes and the population levels in the surrounding area. ε is the error vector with mean zero and constant variance. Predictions of the dependent variable can be made as outlined in Norris (1985).

$$Y^* = \beta X F(z) + \sigma f(z) \qquad (3)$$

where Y^* is the predicted dependent variable, β and X are as defined above, $z = \beta X/\sigma$, $F(z)$ is the cumulative standard normal distribution function, $f(z)$ is the standard normal density function and σ is the standard error of the estimate.

Two models were specified for the province. The first model, SOLS, outlined in (1), was used to determine the numbers of trips taken to a cell as function of biophysical characteristics of that cell and of its neighbours. These neighbours were specified by the first order geographic queen configuration. The second model, Tobit, outlined in (2), was used to determine the numbers of trips taken to a cell as function of biophysical characteristics of that cell.

4.4 Results

Preliminary modelling indicated that there were two separate underlying data generating process. In particular, the Tobit model appeared to be a better fit in the northern part of the province where there is higher proportion of censored data[4]. This assumption was further validated by the fact that the Tobit model predicted few trips in the East Slopes Region, which was contrary to our *a priori* expectations of recreation activity in that Region as identified in Chapter 3. Similarly, the SOLS appeared to be a better fit in the southern part of the province as this model predicted high trip levels in cells located in the East Slopes Region as expected. These considerations led to the use of the Tobit specification in the north and SOLS in the south (Figure 4)[5].

In addition to the standard regression diagnostic tests, the prediction performance of each model was examined by generating a hold-out sample of cells. This sample involved a random selection of about 10% of the cells which were left out of the estimations. The ability of the models to predict the trips in this holdout sample provided a further indicator of performance (Tables 2a and 2b). The parameter estimates of the out so sample models for the north and south are provided in Appendices A and B.

4.4.1 Spatial OLS (SOLS)

The spatial econometric model was estimated using GeoDa 0.9 (Anselin 2003). Table 3 provides the parameter estimates of the SOLS and the diagnostics for the two sources of spatial dependencies. These diagnostics are computed based on LM tests and are shown to be robust (Anselin et al. 1996). These tests led to rejection of the hypothesis of no spatial dependence. As suggested by Anselin and Rey (1991), a mixed regressive-spatial autoregressive model, where $\rho \neq 0$ and $\lambda = 0$ was chosen since the LM test value was higher for the spatial lag than the spatial error. The parameter estimate for the lag coefficient ρ is -0.15 suggesting that there is a negative spatial correlation between trips at a grid and its neighbours.

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[4] The area of the province north of Cold Lake is defined as northern Alberta.

[5] Note that for consistency, the sample size in the north, like the south, is also defined by the first order queen configuration.

A robust covariance model (Table 3) where the standard errors of the spatial model were corrected to account for an unspecified form of hetereoscedasticity, is provided. White's adjusted covariance matrix was used in generating these model parameters. This correction was possible since we could spatially filter the dependent variable using the SOLS, and obtain parameter estimates using regular OLS where the spatially filtered trip variable was regressed on the independent variables. The spatial filtering process is conducted using the following equation: (Anselin 1999).

$$(Y - pWY) = \alpha + \beta X + \varepsilon \qquad (4)$$

Although the standard error for the spatial lag parameter cannot be corrected, even a three fold increase in the standard error would lead one to not reject the hypothesis that the spatial lag parameter equals zero. The inclusion of the spatial lag in the regression model deflated some OLS parameters while others were strengthened.

The signs on the parameters were not all as expected. The inclusion of campgrounds, the presence of human settlements in particular regions of the province, and water access measures were all positively related with trips to a cell. The campground variable (CMPG) was positive, reflecting the fact that recreationists are drawn to areas with campgrounds for recreation. The dummy variables SETMTN was positive and significant. This suggests that the presence of human settlement in the Mountain Region was an important determinant of the number of trips taken to that cell.

Some of these settlements include highly sought after places such as Canmore which borders the Banff National Park. The population variable was negative and statistically insignificant. This is rather surprising given that previous recreation demand studies (Brainard et al. 2001; Bateman et al. 1996) have found the population sizes in proximity to recreation areas to be significant determinants of recreation demand.[6]

Both linear and quadratic parameters on the amount of shore length had an insignificant but positive effect on the numbers of trips. This confirms to prior expectations in that given a relative scarcity of water area in the south presence of water there is likely to attract recreationists. However, a cubic form for this variable may be more appropriate. A cubic model is shown in Appendix C and as expected, the cubic term is negative indicating that greater water area eventually will have negative impacts on the numbers of trips taken to a cell. However, out of sample prediction (Table 2b) indicated that the cubic form, model 6, was not the best fit.

Given the nature of the trip data, a count data model (such as the Poisson model) may be a more appropriate model to apply to these data. However, the framework for incorporating the Poisson model into spatial econometric method is currently unavailable and is beyond the scope of this present study.

The parameter estimates on the linear and quadratic parameters for the road access variable suggest a convex relationship with trip levels. While the number of trips initially declines as road access increases, trip levels eventually become positively associated with roads. This relationship can be explained by the fact that while a higher density of roads offers access, it restricts the amount of recreation opportunities that is available. This may be particularly true near population centres where road types are not conducive to recreational activities such as wildlife viewing, dirt biking and off road vehicle use. In contrast, the road networks away from the population centres are more suitable to such activities and would be expected to provide better recreational opportunities.[7] While we did not test this hypothesis, anecdotal evidence suggests this likely occurs.

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[6] The population and the road variables exhibit some collinearity (0.43). This is not surprising given that road networks often exist around human settlements. Different model specifications indicated that the road variable was more robust, however, the population variable was included in the final model for theoretical reasons.

The parameter on the forest variable was negative and was contrary to prior expectation as previous recreation studies (Brainard et al. 2001; Bateman and Lovett 2000) have found forest cover to be positively related to recreation levels. The model result may be related to the fact that a majority of recreation trips from the NSINC sample occurred in non-forested areas in the province. Furthermore, the use of crude forest cover data could have contributed to the result but lack of better quality data prevented further analysis.

4.4.2 Tobit

The Tobit model was estimated using LIMDEP version 8. As explained above, the Tobit specification was used for the northern area of the province. The last column of Table 3 provides parameter estimates for this model.[8] Like the SOLS, the signs on the parameters were not all as expected. The shore line length, road, campground and population variables were all positively related with the number of trips to a cell.

The campground variable (CMPG) was positive and significant, reflecting the fact that recreationists are drawn to areas with campgrounds for recreation and confirms with prior expectations. The population variable was positive but statistically insignificant.

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[7] These recreational opportunities exist largely because of the network of logging roads (McLevin 2004.)

[8] We attempted a Bayesian spatial Tobit model based on James Lesage's sartg routine in MATLAB. This method is based on Gibbs sampling technique. However, it failed to converge, possibly due to high percentage (>95%) of data that occurred as zeros, but this hypothesis was not tested.

This result is contrary to findings obtained by Brainard et al. (1999) and Bateman et al. (1996) who found population in proximity to recreation areas to be significant determinants of recreation demand. The significant positive parameter estimate on the road variable suggests that as road access increases, trips to a cell also increase. This suggests that in the north, where there are relatively fewer road networks than the south, increasing those networks likely translates into better outdoor recreation opportunities.

The linear parameter on the amount of water area had a significant positive effect on the numbers of trips. However, the negative parameter for the quadratic of that variable suggests that as water area increases beyond a particular level, the number of trips would decline. This confirms our prior expectations that given a relative abundance of water area in the north, this attribute likely is not highly desired in determining trips to a cell.

The parameter on the forest variable was negative and was contrary to prior expectation as outlined above. Given the relative abundance of forested areas in the north, presence of this attribute likely does not draw recreationists to a cell. Thus, the predicted insignificance of that variable is not surprising. However, our use of crude forest cover data may also contribute to the negative parameter estimate.

4.4.3 Predicted Trip Map

The TOBIT and SOLS regression models were used to predict the distribution of trips, inflated to the provincial level, for Alberta using the procedures outlined in Chapter 3. The predictions are displayed in maps in Figures 5a and 5b respectively. Blank spots in the maps show areas where the models predicted zero trips. Based on *a priori* expectations, it appears that the SOLS does a more realistic job of predicting the spatial pattern of recreation in the western Mountain Region and the southern portion of the province, while the TOBIT models appear to be better at doing this in the north.

Both models predicted high trip levels to cells near human settlements. In the south, this is reflected in high trip levels around the population centres of Edmonton and Calgary. In particular, the cell with the highest trip level in the province in 1996 was predicted to be in the Edmonton Region. While this is somewhat surprising, it is likely that those trips are generated due to a high density of roads in that cell.[9] The model also suggests that few trips were taken to the south-eastern Region which likely is realistic since this area includes the Suffield military base. In the north, higher trip levels were associated with population centres such as Grande Prairie and Cold Lake. Tables 4a and 4b provide details on cells with high trip counts and associated attributes in those cells for the north and south Regions respectively.

4.5 Discussion and Conclusions

These findings suggest that the infrastructure map does not provide an accurate spatial depiction of recreation values. Of the 13.2 million[10] trips taken in 1996 the econometric models presented in this chapter predict approximately 2 million of this total to be associated with infrastructure such as campgrounds. There are significant recreation areas in proximity to population centres in the province that do not depend on infrastructure. While this seems an obvious conclusion, the fire management agency was also interested in knowing more about recreation values in forests in or near urban areas. These more "urban" forests were not specifically identified in the model as they are not part of the traditional provincial forest inventory. The models examined in this study seem to identify this and suggest that in terms of "value" that these areas maybe a significant destination for recreation. Of course the models also predict significant trip activity in forests that the fire management staff are typically concerned with which largely involve industrial managed forests under tenure to the forest industry.

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[9] The road density is highest in the south in that cell and also note that the parameter estimate on the quadratic of that variable is positive.

[10] Excludes trips taken to National Parks.

In terms of value, the analysis of the NSINC data, when inflated to the provincial level, suggests that overall, Albertans took about 13.2 million trips to engage in outdoor recreation activities in 1996 (DuWors et al. 1999). The survey also collected estimates of consumer surplus associated with these activities and ranged from about $9.00 to $19.00 per trip depending on the activity (FPT 2000). Assuming the trip activities examined in this study included wildlife viewing, hunting, fishing and outdoor activities in natural areas, a weighting average of the consumer surplus per trip was calculated to be about $ 21.00/trip in 1996 for the province. The overall consumer surplus from these activities is approximately $233 million. While this value exceeds than one reported in DuWors et al. (1999)[11], the predicted consumer surplus nonetheless illustrates that outdoor recreation generates significant value that should be accounted for in forest management decisions.

Furthermore, examining the spatial distribution of consumer surplus values in the two study areas also conforms to *a priori* expectation of the distribution of recreation activities. Note that the spatial distribution of consumer surplus maps are similar to Figures 6a and 6b in that high trip areas are associated with high value cells. In the south, the Mountain Region is highly valued for recreation activities generating substantial consumer surplus values. The Region surrounding the population centres such as

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[11] The reported value is 220 million. This discrepancy could have resulted from averaging the consumer surplus value and multiplying it by the trips. Also, the National Park trips are excluded, this can further inflate the value.

Edmonton and Calgary also show high recreation value. In the north, recreation values are associated with population centres such as Cold Lake, Grande Prairie and High Level.

Despite some shortcomings this modelling exercise is valuable since explicit consideration of recreation values in allocating resources would be advantageous in that these values are closely linked to the presence of recreationists and not necessarily infrastructure. Therefore, during fire events, directing resources to high value recreation areas fulfill a fire management goal of protecting highest values at risk, as well as identifying areas of the landscape where the suppression efforts are to be directed.

4.6 Future Research

It is unfortunate that the most comprehensive data available to conduct analyses such as this are rudimentary in nature and out-dated. The 1996 NSINC information is the only available data on recreation trips throughout the province that could be found to conduct this analysis. Furthermore, the inaccuracies involved in the spatial referencing of this information will require a more thorough analysis of spatial econometric concerns than reported here. In particular, analysis with varying cell sizes and alternative specifications of the spatial weights matrix that may more explicitly account for the landscape attributes could be conducted. Also, given the truncated nature of data, there is a need to develop a framework to incorporate truncated models into the spatial econometric methods. In addition, the notions of recreation economic value developed here are static and rudimentary.

A study such as this represents a first step in developing a more comprehensive approach to including recreation concerns in a wildfire management framework. It also illustrates the type of information required to conduct this type of analysis in future studies. In particular, a systematic method to collect and update outdoor recreation data by various public lands management agencies is needed. Towards that effort, the following chapter examines the extent of recreation activity in the East Slopes Region, defined as the subset of the Mountain Region, using an expert judgment approach by using survey data collected from SRD personnel.

4.7 A Practical Application: Recreation Values Lost in Chisholm Fire

This section examines the impact on the recreational values predicted above due to the Chisholm fire of 2001. While Chisholm Region is not a highly sought area for outdoor recreation, this type of analysis nonetheless serves to illustrate how the recreational values could be incorporated in fire management.

The hamlet of Chisholm is located approximately 150 km north of the city of Edmonton. The Chisholm fire burned for nine days in May 2001 and consumed approximately 116, 000 hectares of forests in addition to infrastructure in the hamlet and surrounding areas. The suppression cost of the fire was approximately $10 million (Chisholm Fire Review Committee 2001). While the monetary costs of fighting fires are often highlighted, the impacts of wildfire on recreational values are often ignored in fire management decisions.

The area surrounding Chisholm does not have any parks but does contain three natural areas which have no facilities but provide opportunities for low impact recreation. Other forms of recreation in the area include hunting, fishing and random camping in the public forest lands in the area. As demonstrated previously, recreation value should be tied to participation and not necessarily associated with availability of recreation infrastructure. Thus, deriving recreation value required examining the level of participation for that area.

4.7.1 Derivation of Trips and Associated Economic Value

The economic value of recreation in the area of the Chisholm fire was derived using the results of the Tobit model discussed above (Table 3). A GIS image of the Chisholm fire was overlaid with the GIS image of predicted trips. The area of intersection between the fire and the provincial 100 km^2 grid was considered to be the area burned. Although the 1996 NSINC sample contained no trips to the cells in this area, it is likely that there were some trips from Albertans and the presence of biophysical features such as roads and water bodies in these cells would lead the model to predict some trips to the area. Indeed the model, when inflated to the provincial level, predicted approximately 14,000 trips, representing about $263,000 in consumer surplus for this area (Figure 6). These numbers represent less than 1% of the total trips taken in the province and less than 1% of the total provincial recreation value.

Most of these predicted trips were likely for day use by the residents of Chisholm as well as hunting, fishing and off-highway vehicle use by these people and other Albertans living nearby. For 2000, SRD (2004) estimated the numbers of hunters in the wildlife management unit surrounding Chisholm to be approximately 2,700. However, this figure is likely an overestimate due to double counting since a hunter may hold licenses for more than one species being hunted. While such local level data is not available for fishing, Chisholm area includes many lakes and rivers including the Lesser Slave Lake and the Athabasca River (Mitchell 2004). Furthermore, this area also contains numerous opportunities for random camping and off highway vehicle use (AHOVA n.d).

This type of analysis aids fire managers in several ways. First, recreation values are tied implicitly to recreationists who are considered highest values at risk in wildfire. Identifying areas of the landscape where recreationists frequent can aid the managers in resource allocation priorities. In particular, since a higher protection priority is accorded to recreationists, it is desirable to focus on recreation values. From a recreation value perspective in the Chisholm area, limiting fire fighting resources to the evacuation of these few recreationists rather than extensive fire suppression effort is probably warranted. This can help minimize the fire suppression expenditures as well as free scarce fire fighting resources for high value recreation areas, such as the East Slopes Region. However, some discussion on the limitations of this analysis is warranted. First, the recreation value itself may be affected by the fire. This impact could be positive (ie increased trips taken for wildflower gathering and mushroom picking) or negative (ie decreased trips for fishing due to stream damage). In the Chisholm area, fire may have created ideal habitat for some game animals which may stimulate increased hunting trips. These factors can have an impact on visitation levels and thus consumer surplus values. Second, the assumption that recreation values are lost due to the fire is naive. Recreationists likely seek other nearby areas to Chisholm to recreate. Third, the effects of fire on the landscape fade over time. This loss of value is likely not permanent but will recover as the forest grows back over time.

Table 1a. Variable definitions and mean values (standard deviations, where appropriate, in parenthesis) for the NSINC sample of trips in the north (N=1382).

Label	Definition	Mean (SD)
Y	Number of trips that occurred in a cell from NSINC min = 0, max = 227	1.86 (14.47)
HPL	Shoreline of water body (km)	55.32 (64.63)
RD	Length of road (km)	36.43 (36.64)
FORST	Area of cell included in the Forest Protection Area (km^2)	84.05 (33.64)
CMPG	Number of campgrounds	0.168 (0.71)
P70KT	Population within 70km radius (in thousands)	16.31 (17.62)

Table 1b. Variable definitions and mean values (standard deviations, where appropriate, in parenthesis) for the NSINC sample of trips in the south (N= 2143).

Label	Definition	Mean Value (SD)
Y	Number of trips that occurred in a cell from NSINC min = 0, max = 1136	5.26 (43.71)
HPL	Shoreline of water body (km)	19.55 (29.80)
RD	Length of road (km)	1269.97 (2966.63)
FORST	Area of cell included in the Forest Protection Area (km^2)	29.17 (44.67)
CMPG	Number of campgrounds	0.30 (1.2)
P120KT	Population within 120km radius (in thousands)	425.74 (459.38)
SETMTN	Settlement that is in close proximity to the Mountains (1 = close to Mountains, 0 = not close)	0.023 (0.15)

Table 2a. Measures of the prediction performance of the regression models using a holdout sample of cells (North).

Prediction performance measures	Model 1[a][*]	Model 2[a]
MAE (mean $\lvert Y_{actual}-Y_{predicted}\rvert$)	2.67	4.08
No. of cells with 0 trips (actual = 18)	24	14
No. of predicted trips (actual=64)	0	64

[*] Based on the minimum MAE value, model 1 was chosen (Table 3)

[a] Different specifications of the Tobit models for predicting trips in the North

Table 2b. Measures of the prediction performance of the regression models using a holdout sample of cells (South).

Prediction performance measures	Model 1[b]	Model 2[b]	Model 3[b]	Model 4[b]	Model 5[b][*]	Model 6[b]
MAE (mean $\lvert Y_{actual}-Y_{predicted}\rvert$)	15.60	11.16	11.61	11.16	10.54	11.21
No. of cells with 0 trips (actual = 28)	13	14	14	14	17	20
No. of predicted trips (actual= 417)	486	351	351	351	292	315

[*] Based on the minimum MAE value, model 5 was chosen (Table 3)

[b] Different specifications of the spatial OLS models for predicting trips in the South

Table 3. Parameter estimates (standard errors) for four models explaining recreation trips to 100 km^2 cells in Alberta.

Variables	OLS	Spatial OLS (SOLS)	OLS with Robust Covariances[a]	Tobit (normalized coefficient)
Constant	1.91	2.14	2.13	-2.69 **
	(2.83)	(2.81)	(5.47)	(0.294)
HPL	0.064	0.075	0.07	0.0097 **
	(0.072)	(0.072)	(0..09)	(0.0035)
HPL2	0.0001	0.0001	0.0001	-0.00003 *
	(0.0007)	(0.0007)	(0.001)	(0.000016)
RD	-0.164**	-0.17**	-0.17	0.015 **
	(0.052)	(0.052)	(0.16)	(0.0022)
RD2	0.002 **	0.002 **	0.002 *	
	(0.0002)	(0.0002)	(0.001)	
FORST	-0.04 **	-0.05 **	-0.048	-0.0044 **
	(0.044)	(0.023)	(0.031)	(0.002)
CMPG	4.24 **	4.34 **	4.33	0.187 **
	(0.69)	(0.68)	(3.29)	(0.0598)
P70KT				0.0000022
				(0.0000042)
P70KT2				-0.000325
				(0.000199)
P120KT	-0.0022	-0.01	-0.002	
	(0.02)	(0.01)	(0.002)	
SETMTN	21.02 **	22.16 **	22.127*	
	(5.47)	(5.45)	(12.34)	
σ				94.65
ρ		-0.15 **		
		(0.038)		
LLF	-14101	-14093	-14089	-437.24
R^2	0.082	0.093	0.092	
LM lag	15.0			
LM error	14.3			
LR test (χ^2)		16.59 **		

[a] The dependent variable in this case was spatially filtered

* Significant at the 10% level

** Significant at the 5% level or better

Table 4a. Cell attributes and associated trip and consumer surplus values for 5 highest ranked cells in the north.

Cell attributes						Trips	Consumer Surplus ($1996)	Region
HPL	HPL2	RD	FORST	CMPG	P70kt			
113.796	12949.53	132.4589	14.07371	5	26.86838	68488	1291672	Peace River
25.818	666.5691	112.9742	0	8	27.173	60216	1135673	Grimshaw
106.647	11373.58	155.7717	10.97541	2	62.16637	55838	1053086	Grande Prairie
48.988	2399.824	134.2032	0	4	63.16625	46615	879145	Grande Prairie
5.714	32.6498	208.4497	0	0	64.64519	45985	867269	Spirit River

Table 4b. Cell attributes and associated trip and consumer surplus values for 5 highest ranked cells in the south.

Cell attributes								Trips	Consumer Surplus ($1996)	Region
HPL	HPL2	RD	RD2	FORST	CMPG	P120KT	SETMTN			
0	0	374.77	140456.2	0	0	1126.77	0	101969.5	2185207	Edmonton
82.64	6830.97	286.56	82119.51	0	0	174.87	0	58352.45	1250493	Lethbridge
0	0	284.40	80887.73	0	1	1134.04	0	55278.29	1184614	Edmonton
97.26	9460.35	268.28	71975.62	0	0	236.23	0	50874.94	1090250	Taber
0	0	267.41	71513	0	0	1139.54	0	45817.35	981865.9	Edmonton

Figure 1. The spatial distribution of a sample of recreation trips taken to 100 km^2 cells containing at least one trip in Alberta in 1996.

Source: Statistics Canada and Environment Canada 1999; Sustainable Resource Development

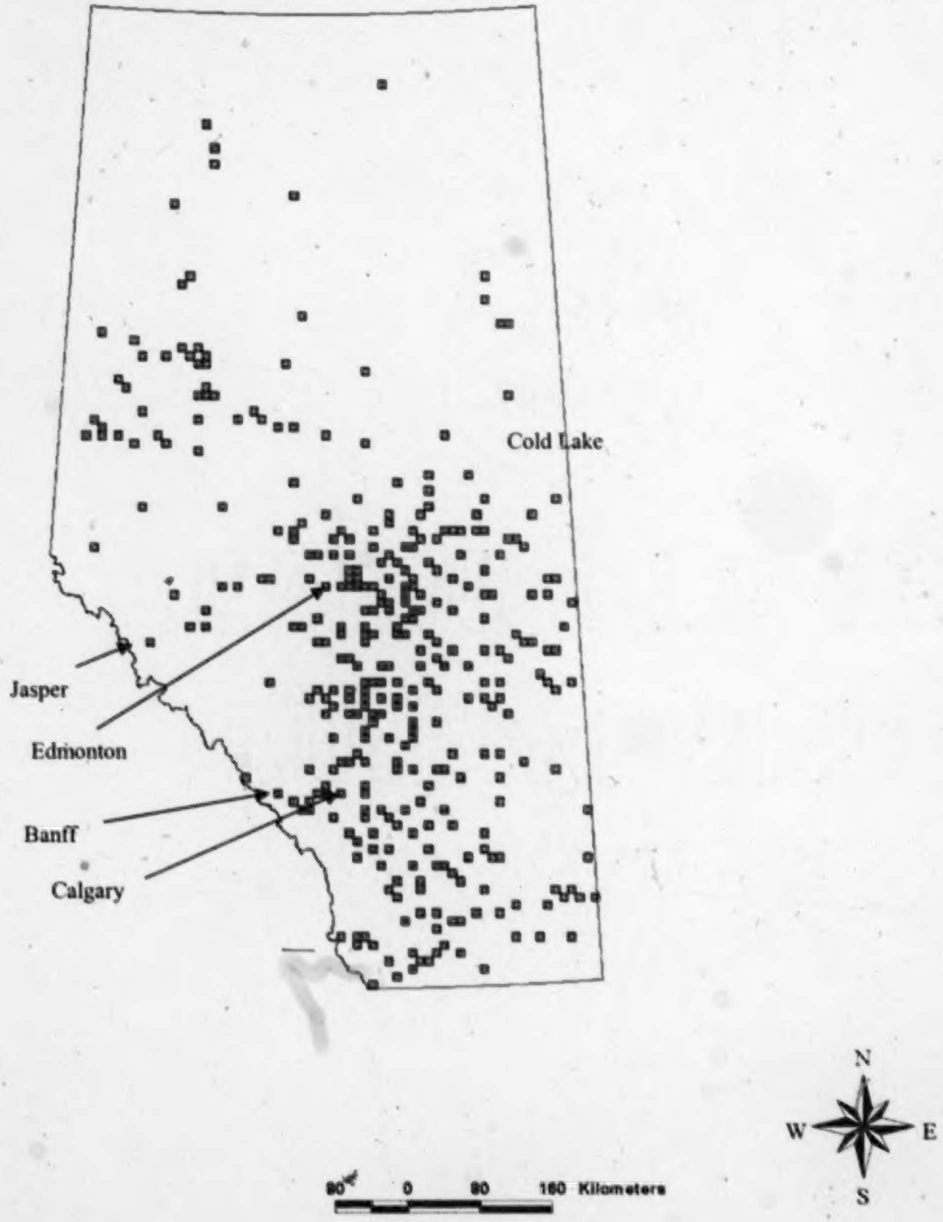
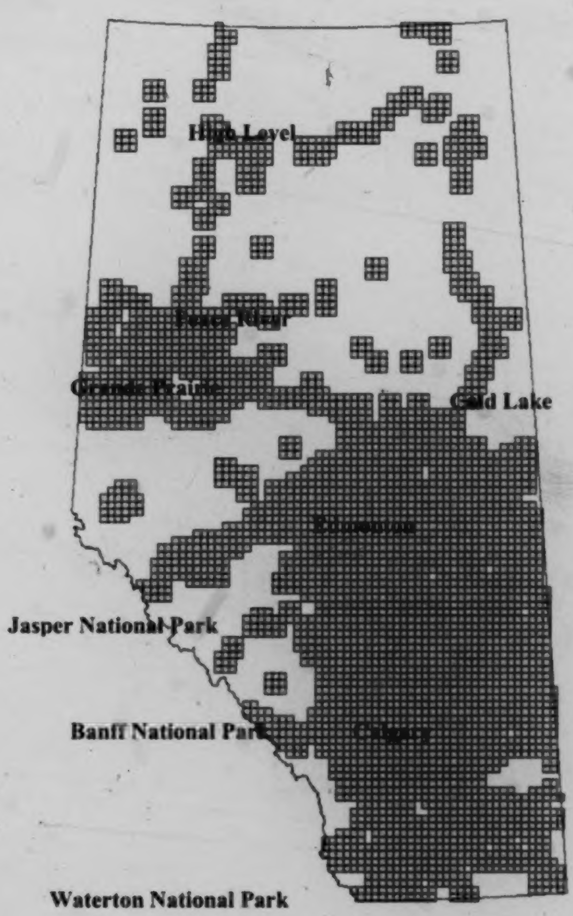

Cold Lake
Jasper
Edmonton
Banff
Calgary
N
W
E
S
80 0 80 160 Kilometers

Figure 2. The study area defined by the 1st order spatial weights matrix configuration (N=3531).


High Level
Peace River
Grande Prairie
Cold Lake
Edmonton
Jasper National Park
Banff National Park
Calgary
Waterton National Park

Note that the National Parks and human settlements contained within them are not included in the analysis.

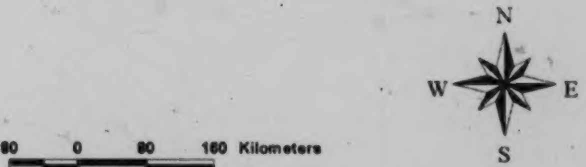

N
W
E
S
80
0
80
160 Kilometers

Figure 3. An illustration of the first order queen configuration used in specifying the neighbours (shaded). In this specification cell number 5 is a neighbour to all other cells with which it shares a boundary. In the first order queen configuration this results in 8 neighbours.

Source: Adapted from Anselin (2002)

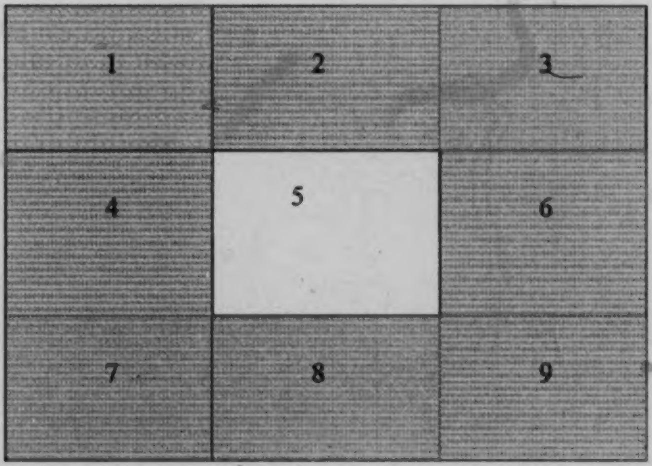


Figure 4. Study areas for the TOBIT and spatial OLS specifications.

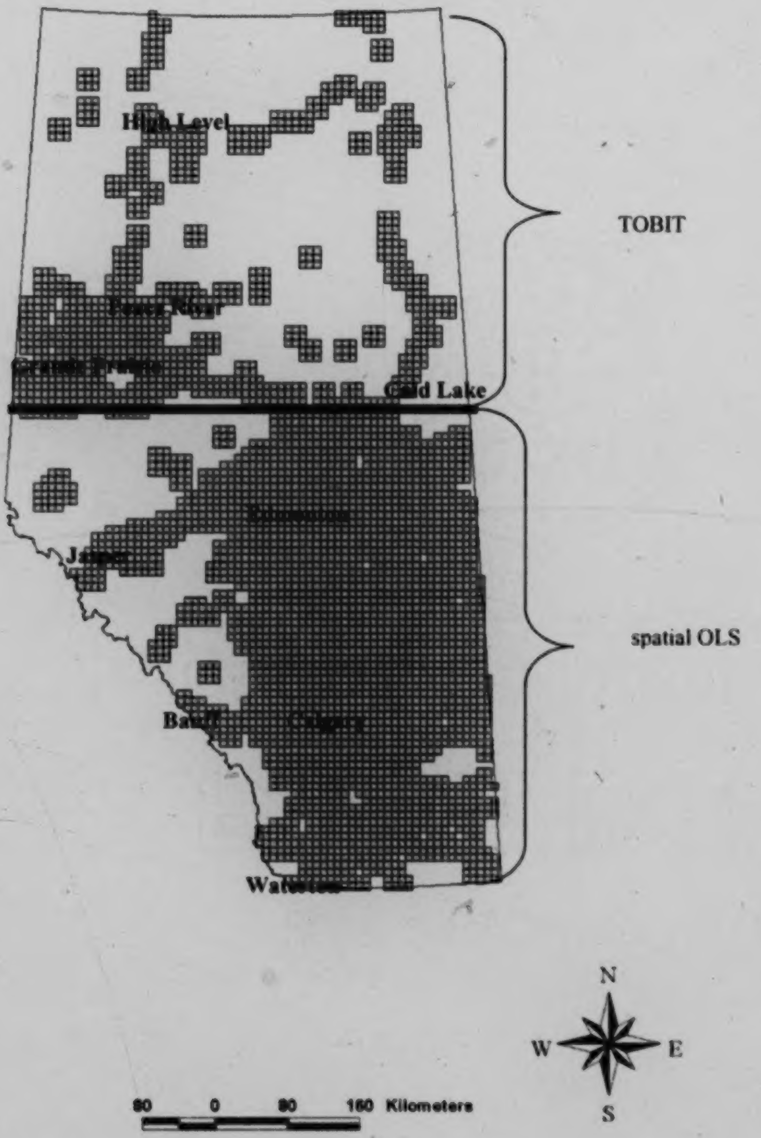

High Level
Peace River
Grande Prairie
Cold Lake
TOBIT
Edmonton
Jasper
spatial OLS
Banff
Calgary
Waterton
N
W
E
S
80 0 80 160 Kilometers

Figure 5a. The predicted spatial distribution of trips for outdoor recreation activity inflated to the provincial level in the North.

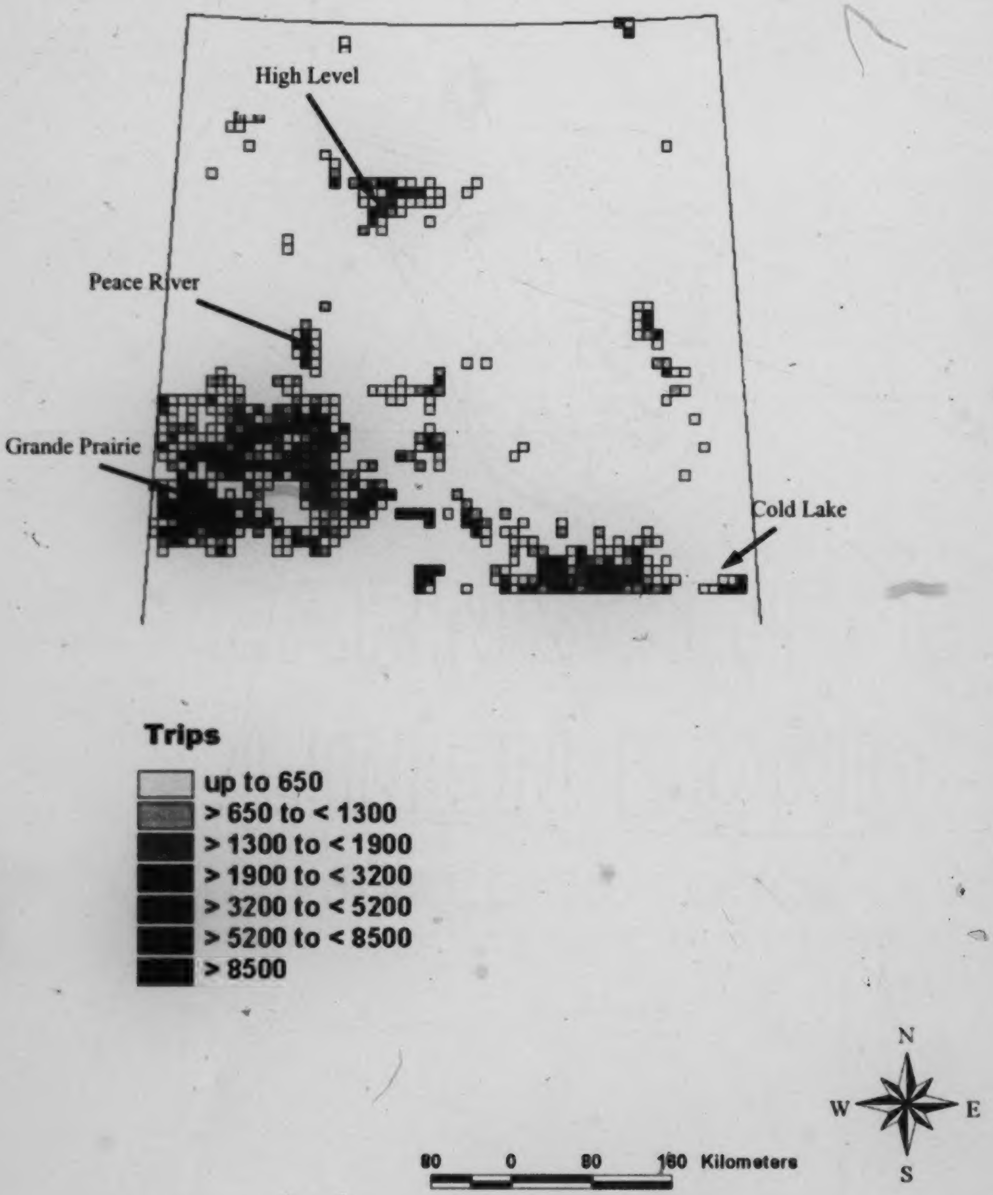

High Level
Peace River
Grande Prairie
Cold Lake
Trips
up to 650
> 650 to < 1300
> 1300 to < 1900
> 1900 to < 3200
> 3200 to < 5200
> 5200 to < 8500
> 8500
80
0
80
160
Kilometers
N
W
E
S

Figure 5b. The predicted spatial distribution of trips for outdoor recreation activity inflated to the provincial level in the South.

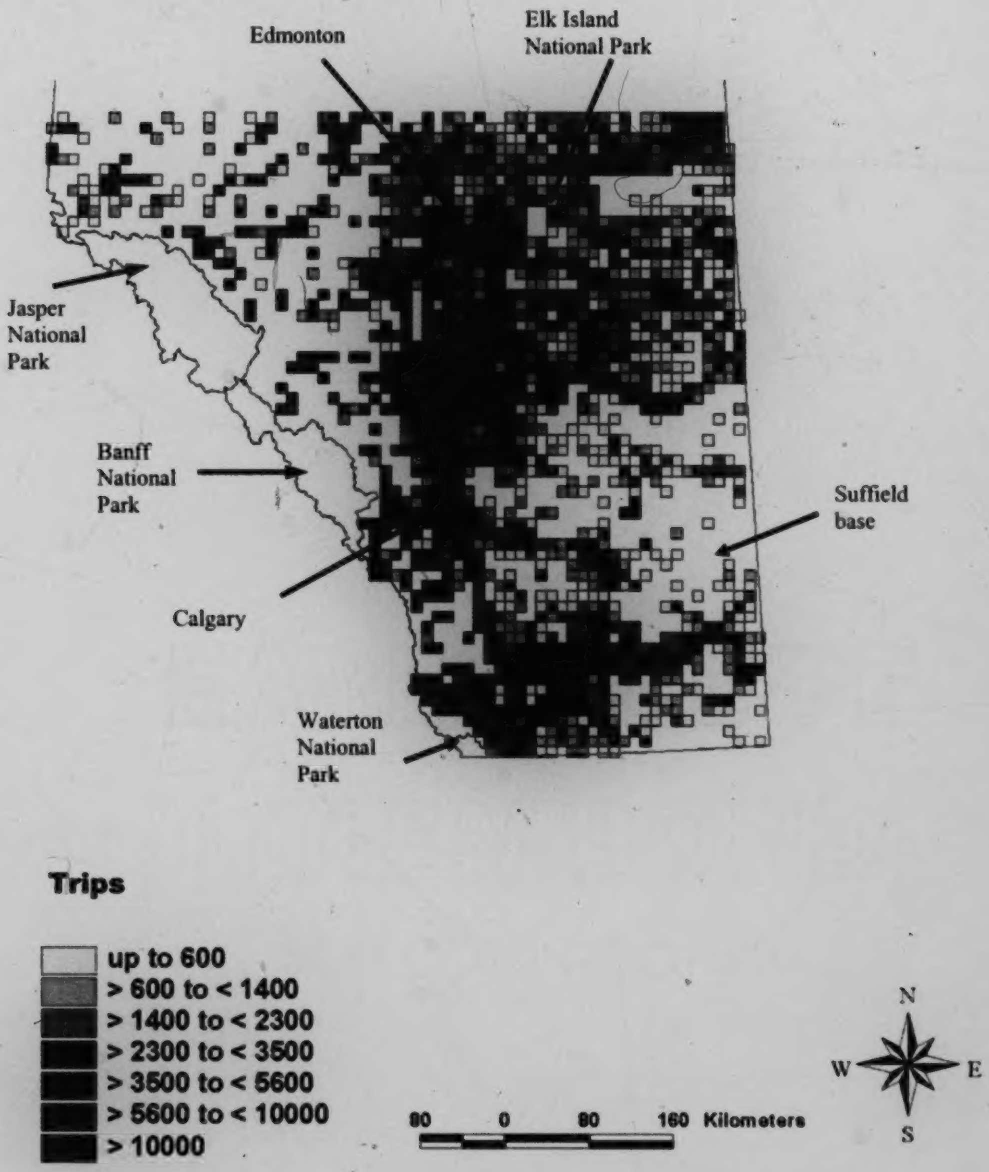
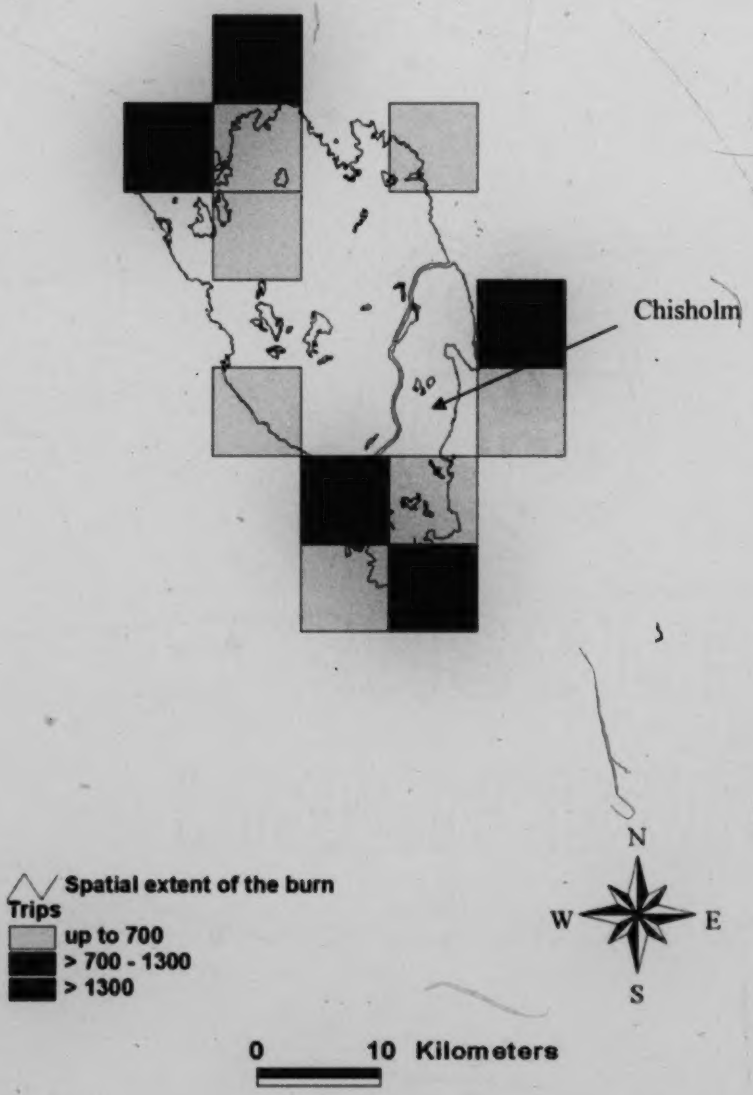

Edmonton
Elk Island National Park
Jasper National Park
Banff National Park
Suffield base
Calgary
Waterton National Park
Trips
up to 600
> 600 to < 1400
> 1400 to < 2300
> 2300 to < 3500
> 3500 to < 5600
> 5600 to < 10000
> 10000
80 0 80 160 Kilometers
N
W
E
S

Figure 6. The total burn area and the predicted recreation areas affected by the Chisholm fire in 2001 displayed in 100 km^2 cells.


Chisholm
Spatial extent of the burn
Trips
up to 700
> 700 - 1300
> 1300
N
W
E
S
0
10 Kilometers

Chapter 5

Refining Spatial Patterns of Forest Recreation: A Detailed Examination of the East Slopes Region

5.1 Introduction

The extent of recreation activity in the Mountain Region straddling the Alberta-BC border was identified in Chapter 4. A subset of the Mountain Region, the East Slopes Region, can be defined as the mountain region excluding its National Parks (Figure 1). There are several factors which contribute to the popularity of the East Slopes Region including its proximity to some of the population centres in the province and to the Rocky Mountains. Furthermore, the network of access roads in this Region due to the forestry and energy industries, also offers access to areas for outdoor recreation. The importance of access is well documented in the recreation literature (e.g. McFarlane et al. 2003; Queen et al. 1997) and was identified in the econometric models presented in Chapter 4. The presence of water bodies can also be expected to have positive impact on outdoor recreation in the Region as these would be suitable for a variety of recreation activities such as fishing and boating.

Much of the recreation activity in the East Slopes Region likely occurs outside of the publicly provided, managed recreation sites. This activity is referred to as random camping by land management agencies. The extent of this activity is probably substantial as suggested by the study of Williamson et al. (2002) referenced earlier. Thus, in order to more accurately assess the levels of recreation activities in the Region, it is important to include random camping as well as recreation in more formally managed sites in a recreation analysis.

Other reasons to account for the spatial extent of random camping is highlighted by the fact that currently, recreation values are assumed by the Provincial Government to be reflected through the presence of publicly provided recreation infrastructure at a site. Since random camping occurs outside of sites with infrastructure, excluding random camping may seriously understate total recreation use in the East Slopes Region. Furthermore, as outlined in Chapter 2, an explicit consideration of recreation values in fire management is advantageous in that these values are closely linked to the presence of recreationists, and implicitly human life. Therefore, understanding the spatial extent of both the managed and unmanaged recreation activity will assist the direction of resources and suppression effort to high valued recreation areas, as well as identifying areas of the landscape where human life is at risk.

This chapter focuses on refining the spatially explicit indicators of forest recreation derived in Chapter 4 for the most important recreation region in the province. As such, this chapter attempts to overcome the limited spatial coverage for the East Slopes Region contained in the 1996 National Survey on the Importance of Nature to Canadians (NSINC) and other existing recreation studies. In particular, the goal of this chapter is to solicit information on the random camping activities in the East Slopes Region using an expert judgment approach and to incorporate these activities with other existing recreation studies to derive a more complete spatial understanding of recreation activity in this Region.

First, the chapter provides an overview of the components of landscape over which outdoor recreation occurs in the East Slopes Region. This is followed by discussion on data collection and econometric modeling. In particular, econometric model of random camping participation is developed. The goal of this model is to identify biophysical attributes of the landscape that drive random camping. Results and conclusions summarize the findings of the analysis. A case study which further highlights the need to incorporate random camping activities in a particular area of this region is also provided.

5.2 An Overview of Outdoor Recreation Opportunities in the East Slopes

There are numerous layers which depict the various categories of outdoor recreation opportunities in the East Slopes Region (Figure 2). These include the Provincial Parks (Parks), the Provincial Recreation Areas (PRAs), backcountry camping areas, and random camping areas. In addition, there are other administrative units such as ecological reserves, natural areas, wilderness areas, wildland parks and Wilmore Wilderness Park which provide some opportunities for outdoor recreation in the East Slopes Region. However, these areas are generally not road accessible and have minimal levels of use (Alberta Community Development 2001). Since recreation data are not readily available for these areas, recreation activities occurring in these areas are not included in the analysis.

It is noted that there are three National Parks (NPs), Waterton, Banff and Jasper, that border the East Slopes Region. These NPs contain recreation infrastructure such as campgrounds and hiking trails and are popular destinations for recreationists. However, the NPs fall outside of Alberta's fire management responsibility and thus, recreation activity occurring in them is not included in this study in deriving the total picture of outdoor recreation in the East Slopes Region.

The network of Parks, PRAs, and backcountry campgrounds are collectively referred to as managed sites. The Parks tend to be the most developed and provide amenities such as playgrounds, interpretative services, showers and dump stations and other types of infrastructure (McFarlane et al. 2003). They are often located along highways and are more easily accessible to recreationists. The PRAs, initially called Forest Recreation Areas, were established by the Alberta Forest Service in the 1960s at more popular random camping sites in response to concerns over wildfires resulting from careless use of campfires and environmental impacts of random camping in the forest (McFarlane et al. 1996). These areas provide a semi-primitive recreation experience with rustic or basic infrastructure and services. While there was no service fee initially, the Forest Service began charging a camping fee in 1992. Subsequently, these areas registered a 50% decline in use in 1992 from the previous years (McFarlane et al. 1996). The PRAs were initially managed by the Alberta Forest Service but changes in administrative responsibilities since then have meant that the operation and management of many PRAs are currently privatized (McFarlane et al. 2003).

Backcountry campgrounds are rustic and provide recreation opportunities in a primitive setting with minimal facilities. These campgrounds are managed for low-impact use such as hiking, camping and wildlife viewing. Other activities such as equestrian use are permitted only on designated trails (Alberta Community Development 2004). There are numerous backcountry campgrounds in Kananaskis Country which is located near Calgary.

McFarlane et al. (2003:3) describe random camping as "camping at unmanaged sites on public land where no services and facilities are provided and no camping fee is charged." They can occur anywhere on the public forest lands but are most often found near logging roads, water bodies or other scenic vistas (Mandrusiak 2003). Unlike the recreationists at managed sites, random campers have few restrictions on the type of recreation activities they are allowed to engage in. Some of the popular activities include off-highway vehicle use and large social gatherings (Mandrusiak 2003). In order to develop a more complete picture of recreation in the East Slopes Region, recreation activities occurring in managed sites and random camping areas were used.

5.3 An Overview of the Areas used in the Study

The six offices of the Alberta Sustainable Resource Development (SRD) from which the data were solicited were Blairmore, Calgary, Edson, Hinton, Grande Cache and Rocky Mountain House areas of the East Slopes Region (Figure 1).[1] One of the main goals of the staff in these offices is wildfire prevention. As such, staff conduct patrols in their respective districts to ensure compliance with local land use management guidelines (Mandrusiak 2003). These patrols also give the provincial forest managers knowledge on the spatial distribution and extent of recreation activity occurring in the landscape.

However, the extent of recreation activity varies among the six areas. Past studies (McFarlane et al. 2003; Boxall et al. 2001 and Boxall et al. 1996) have shown that significant recreation activity occurs in Calgary, Edson, Hinton and Rocky Mountain House areas. Field visits also showed the Blairmore area to contain substantial recreation activities. Grande Cache, the most northern area, is expected to have relatively few recreation activities.

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[1] It is noted that the terms "East Slopes Region", "area" and "area office" used here are solely for the purpose of this study and do not necessarily correspond to administrative areas defined by the Alberta Government. Detailed maps for the areas are provided in the Appendices B – G.

5.3.1 Landscape Attributes

The SRD provided landscape attribute data layers for the province in a Geographic Information Systems (GIS) format. The data pertaining to the East Slopes Region was extracted using ArcView. This data contained landscape features such as road networks, hydrological features and human settlements. The road network was disaggregated into four road classes in an attempt to understand the impact of road quality on the level of recreation activity. The hydrological features were aggregated and their areas were converted to shoreline lengths. As discussed in Chapter 4 this aggregation may provide a better measure of recreational access to water bodies. Information from the 2001 census was used to determine if population in proximity to cells had an influence on their levels of recreation. Based on interviews with land management personnel, 100 km distances from each cell were buffered. The population levels within each buffer were estimated and used as independent variables. Note however, that population levels from neighbouring provinces and states next to Alberta's boundaries were excluded from consideration in constructing this variable.

5.3.2 Spatial Considerations

A challenge in collecting recreation data is that recreation activities are spatially dispersed on the landscape. In particular, unlike the Parks or PRAs, random camping activities are not spatially referenced to a particular recreation infrastructure. This, and the fact that spatial information about the recreation locales was required to determine what influenced the level of activity and to predict future recreation use, resulted in the development of spatial units. The choice of the spatial unit rather than using specific point location allowed some consideration of this dispersion as well as the development of indicators of relative attractiveness of the units of recreation.

There are a variety of ways to define spatial units as discussed in Chapter 3. Furthermore, a review of literature in Chapter 4 found that recreation studies have used grid tessellation. The impetus for selecting the regular tessellation and the cell as a unit of analysis came from discussion with the research partners as well. In addition, the stated objective of refining the spatial pattern of recreation activity from Chapter 4 also influenced the cell size selection for the grid tessellation[2]. Thus, the spatial unit of analysis was defined as equal area cells of 25 km^2.

5.4 Existing Recreation Data

Collecting recreation data is a challenging task. Chapter 3 has outlined some of the data sources and limitations contained therein. Much of the recreation data for the East Slopes Region are currently derived from the system of managed sites. As described above, these sites typically refer to areas that have some recreation infrastructure such as campgrounds, picnic tables, washroom and other amenity services. They also charge a fee for an overnight stay at the sites. The most developed sites tend to be the Parks.

5.4.1 Data on Managed Sites

There are three main sources of recreation data for the managed sites in the East Slopes Region. The Parks and Protected Areas Division of the Alberta Department of Community Development, compiles visitation statistics for the managed sites. In addition, there have been specific studies such as McFarlane et al. (2003), McFarlane and Boxall (1998), and McFarlane et al. (1996) who have collected outdoor recreation data for PRAs in some areas of the East Slopes Region. Boxall et al. (2001) also conducted a study of backcountry camping in Kananaskis Country in the East Slopes Region. This chapter assumes that the patterns of recreation activity described in these various studies have not changed significantly over time.

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[2] Grid refers to the entire lattice composed of individual cells.

5.4.1.1 Alberta Provincial Parks (Parks)

There are 10 Parkss in the East Slopes Region. These Parks range in size from 128 to 50,000 ha (Alberta Community Development 2002a). The majority of Parks in the Region, including the largest, Peter Lougheed Park, are located in Kananaskis Country near the city of Calgary. The other Parks in the Region are located near the towns of Edson, Rocky Mountain House and Crowsnest Pass (Figure 3). All of these parks are well accessed by major roads and contain a variety of amenities and services such as dump stations, concessions, picnic areas, showers and washrooms.

Table 1 displays visitation statistics for each of the Parks in the East Slopes Region and shows that these Parks attracted over 1.1 million day-use and overnight visitors in 2000 (Alberta Community Development 2001). However, this number may be a conservative estimate of the number of visits since visitation data were not available for one of the parks. These levels of visitation were derived from camping permits, self-registration permits, automatic traffic counters, random surveys of visitors, and past estimates of use by staff with Alberta Community Development. Details on data collection and limitations of the methodology can be found in Alberta Community Development (2001). In addition, the Parks and Protected Areas Division also periodically conducts a Camper Satisfaction Survey in selected locations which provide additional information on recreation use (Finzel 2003). A major limitation of these data sources is the lack information on the numbers of trips taken which must be accounted for in this present analysis.

5.4.1.2 Provincial Recreation Areas (PRAs)

There are 70 PRAs in the East Slopes Region. These PRAs range in size from 4 to 4,000 ha (Alberta Community Development 2002a). The PRAs are spatially distributed across the entire East Slopes Region (Figure 3). However, several are clustered in Kananaskis Country including Evan-Thomas, one of the largest PRAs in the Region. Unlike the Parks, the PRAs can be located along secondary routes and provide fewer amenities and services. The PRAs in the Region attracted over 1.1 million visitors in 2000 (Alberta Community Development 2001). However, like the Parks, data for some PRAs were not available so these total levels of visitation are likely an underestimate. The data collection method and limitations of the data are similar to those of the Parks.

The studies conducted by McFarlane et al. (1996) and McFarlane and Boxall (1998) provide improvements over the data collected by the Alberta Government. These studies involved a census of PRAs in the Hinton, Edson and Rocky Mountain House areas. Table 2 provides detailed visitor statistics for the PRAs in the Hinton, Edson and Rocky Mountain House areas from these studies.[3] Furthermore, these studies used trips rather than visitor days as the unit of analysis which is consistent with most recreation economic frameworks for analyzing recreation data and the sources of data were modified self-registration permits. Additional information collected from each camping registrant through the modifications included the number of people in the camping party, the frequency of trips to the campground in the past and the registrants' postal code of origin. This data was used to construct a travel cost model and estimate the economic value of a trip to the PRAs (Boxall et al. 1996; McFarlane and Boxall 1998). The estimated per trip values ($1996) were $58.83 for the Hinton and Edson areas and $55.24 for the Rocky Mountain House area.

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[3] It should be noted however, that some of the PRAs included in these studies fall outside of the East Slopes Region; only those within the region are listed in Table 2.

5.4.1.3 Backcountry Camping

Kananaskis Country is located 90 km west of the city of Calgary and covers 4,250 km^2 (AEP 1998). The Kananaskis Country is managed for multiple uses such as natural resource extraction, cattle grazing and outdoor recreation. There are numerous Parks, PRAs and backcountry campgrounds in Kananaskis Country which attract large numbers of recreationists. For example, the 18 backcountry campgrounds attracted 5,108 visits in 2000 with most campers originating from Calgary, Alberta (Boxall et al. 2001). A majority of the visits occurred in July and August. The campers must obtain a permit to stay at the backcountry campgrounds. This permit collected information such as the postal code of origin the location of the campground where the campers were staying. After removing non-Alberta campers from the permit data, Boxall et al. (2001) constructed a zonal travel cost model to estimate the economic value of backcountry recreation in the Kananaskis Country. This per trip consumer surplus value was estimated to be $168 ($1996). A summary of visitation statistics for the backcountry campgrounds for the year 2000 are provided in Table 3.

5.5 Building the Random Camping Layer

The paucity of studies in Alberta that have explicitly included random camping activities in recreation studies has already been discussed in Chapter 3. Past studies (McFarlane et al. 2003; McFarlane et al. 1996) found random camping to be wide-spread in the Rocky Mountain House area. These studies gathered random camping information by interviewing random campers at their sites and explicitly asking the respondents how many random camping trips they took in the past year. However, unlike the managed sites, the spatial distribution of random camping areas has not been well documented. This lack of this information has implications for fire managers in prioritizing fire events and allocating fire fighting resources. Thus, in order to overcome this gap in what we perceived to be a critical recreation data layer, specific attention was paid to generating information from experts in an effort to understand the intensity and spatial distribution of this form of recreation in the East Slopes Region.

The experts chosen to provide information were Forest Officers and Forest Guardians working in the six area offices responsible for public lands management in the East Slopes Region. These individuals are knowledgeable about random camping activities in their areas since their duties include patrolling the public lands where the majority of random camping occurs. While at present this knowledge is not formally collected, we perceived the officers and guardians holding valuable sources of information. Thus, an expert judgment survey was constructed and administered to selected land management personnel in the six area offices to solicit information on the spatial pattern of recreation and landscape features which attracts random camping activity in the East Slopes Region.

5.5.1 Development of the Expert Judgment Survey

Meyer and Booker (1991) define expert judgment as the combination of the expert's answers, information on how the answers were reached (definitions and assumptions) and ancillary information on the expert themselves (background and experience). Expert judgment is often used to supplement existing data or, in the absence of definitive evidence, such judgment is needed to make informed inferences. This technique has been used in a variety of natural resource management fields including forest fire management (Hirsch et al. 1998; Stocks et al. 1996; Schmoldt 1989), forest operations (Cavanagh et al. 1999), agricultural systems (Roussel et al. 2000) and outdoor recreation (Gan and Luzar 1993).

Preliminary meetings with land management personnel, typically forest officers, were held in each of the area offices. These meetings briefed the officers on the nature of the project and data requirements. The meetings also provided some guidance on the construction of the six forest areas. A pretest of the survey instrument was conducted in two of the area offices with five participants to refine the survey instrument. Based on this pretest, the numbers of random campers rather than the numbers of trips taken to a cell was chosen to be the unit of analysis. The scale used in this analysis was designed to capture the different intensities of random camping in the six forest areas. For example, the preliminary interviews revealed random camping to be more widespread in southern areas of the East Slopes Region than the northern areas.

Random camping activity occurring only during the last week of May to end of September was solicited. This may cause under-reporting in the total random trips taken in subsequent analysis due to fall recreational hunting, but interviews with land management personnel revealed the May to September period as the peak random recreation period.

In addition to the survey, each respondent was provided with a map of their area which was divided in 25 km^2 grid cells. This map contained biophysical features of the landscape such as water bodies, roads and campgrounds. The respondents were asked, "Please rate the cells that you think are major random camping areas using the scale provided below." The respondents were provided with three rating scales and asked to write the ratings on the map for each cell rated. The first scale elicited ratings for the average numbers of random campers in a week for each cell. The second scale elicited when a cell was primarily occupied by random campers (weekday, weekend/long weekend or continuously). The third scale elicited the types of recreation activities that most occurred in the cell (fishing, hunting, off-highway vehicle use, equestrian, hiking, camping, other). The three scales and an example rating for a cell are provided below:

Use Scale: (people/week)	Weekday/weekend stay	Activity type
1= 600+	1 = weekend and long weekend	1 = fishing
2 = 500-699	2 = weekday stay	2 = hunting
3 = 400-499	3 = occupied continuously	3 = OHV
4 = 300-399		4 = equestrian
5 = 200-299		5 = hiking
6 = 100-199		6 = camping
7 = 1-99		7 = other

As an example, a cell rated as 3 1 531 would indicate that on average, 400-499 people a week occupy that cell from the May long weekend to the end of September. Furthermore, that cell is occupied primarily during weekend/long weekend period with individuals for whom the primary recreational activities are hiking, OHV and fishing. The survey also collected ancillary information such as the respondent's major job responsibilities and the respondent's years of experience in the area.

The final survey was administered to eleven land management personnel in six area offices through in person interviews or mail. The rating responses associated with each cell in the maps provided to the respondents were entered in ArcView to provide a spatial distribution of intensity of recreation activity.

5.5.2 Description of the Respondents

The target audience of the rating survey was SRD personnel who were involved in land management decisions in the East Slopes Region. However, a preliminary meeting with SRD revealed that while there are many individuals involved in land management in the Region, not all are knowledgeable about the random camping activity. Furthermore, the availability of some individuals and time constraints also precluded a comprehensive survey. Thus, based on discussions with the SRD, five individuals in the Region were selected. These individuals provided additional contacts to bring the total target audience to 13 individuals. Of these 13, two individuals did not respond to the survey.

The 11 respondents were not distributed evenly across the six areas. Some areas such as Grande Cache and Calgary districts had one respondent each, while the Edson and Hinton areas had three respondents each. A majority of the respondents' responsibilities included wildfire prevention and enforcing forest land use regulations. Some Officers were responsible for enforcing wildlife regulations in addition to forestry regulations. The respondents collectively had 220 years of experience working in the East Slopes Region; the average was 20 years of experience. Further details on the respondents are provided in Table 4.

5.5.3 Relating the Ratings to Landscape Features

In preliminary interviews with the Forest Officers they suggested that access would be a crucial variable in explaining spatial patterns of random camping. Thus, the availability of the road network would be important variable in determining the presence of random camping areas in the landscape. These findings conform to *a priori* expectation of the impact of road network on the outdoor recreation activity since this network offers access and recreation opportunities for off-highway vehicle use to many areas of the landscape. These findings are consistent with field visits to some areas in the East Slopes Region and other studies cited previously. The Officers and Guardians also cited the presence of water bodies in explaining spatial patterns of random camping.

5.5.3.1 Analysis of Ratings

To relate the individual ratings for each grid cell to landscape features, as well as characteristics of the experts, an ordered probability regression model was developed. Because ratings data are discrete but ordered in nature, determining the factors that influence the ratings cannot be analyzed using Ordinary Least Squares (OLS) procedures. OLS would treat the difference between each rating level as the same, whereas in fact they are only ratings (Greene 2000). Similarly, although ratings are discrete variables, the commonly used binary-logit or probit models are also inappropriate since these models fail to account for the ordinal nature of the dependent variable. The ordered probit and logit models have become the standard framework for analyzing ordered data.

Greene (2000) outlines the ordered probit model as follows:

$$Y^* = \alpha + \beta' X + \varepsilon \qquad (1)$$

where Y^* is unobserved but the following are observed:

$$\begin{aligned} &Y = 0 \;\; if\; Y^* \le \mu_0 = 0, \\ &Y = 1 \;\; if\; \mu_0 < Y^* \le \mu_1, \\ &Y = 2 \;\; if\; \mu_1 < Y^* \le \mu_2, \\ &Y = J \; if\; \mu_{J-1} \le \; Y^*. \end{aligned}$$

The parameter α is a constant, β' is a vector of unknown parameters to be estimated, X is a matrix of explanatory variables, and ε, the stochastic term, is assumed to be normally distributed across all observations. Y is observed in J ordered categories, and the μ parameters are unknown threshold parameters separating the adjacent categories to be estimated with β' (Yoshida n.d).

The data examined in this study, however, are panel data since we have information from more than one individual for some cells. Under this condition, the ordered probit specification outlined above will produce inefficient and inconsistent estimates of the standard errors of the parameters in the presence of hetereoscedasticity. This occurs because the model does not take into account unique disturbances associated with each respondent (Haefele and Loomis 2001). Thus, (1) can be reformulated to account for these unique disturbances in addition to the disturbance associated with the model. Haefele and Loomis (2001) outlined the reformulated ordered probability model as:

$$Y^{*} = \alpha + \beta' X + \lambda_i + \varepsilon \quad (2)$$

where Y^{*}, X, β' and ε are as defined above and λ_i represents the disturbance which is specific to each respondent indexed by i. This disturbance has mean zero and constant variance. It is assumed that the disturbance terms are uncorrelated across observations and respondents and λ_i is uncorrelated with X. This model formulation explicitly acknowledges the respondent specific disturbances and creates a hetereoscedasticity error term, $\lambda_i + \varepsilon$ (Haefele and Loomis 2001).

Table 5 provides a description of the set of dependent and independent variables used in the regression analysis and their associated descriptive statistics. These variables were chosen based on prior expectations, interviews with Forest Officers and Guardians, previous studies (McFarlane et al. 2003 and Queen et al. 1997), and results derived from Chapter 4. The variable, EXP, was included to determine if a respondents' number of years of work experience in the area they provided ratings for influenced those ratings. We expected that variable to be statistically significant but had no prior expectations as to the direction (positive or negative) of its parameter estimate.

Several models were estimated. First, the global model, specified by (1), involved aggregating multiple responses in some areas into a single response using the mean of multiple estimates (as outlined in Meyer and Booker 1991[4]) for those cells which had multiple ratings. This global model treated the entire East Slopes Region as one study site with no dummy variables assigned for cells in different areas of the Region. The second model is the random effects model which accounted for respondent specific disturbances specified by (2). There were also two additional models specified for the Rocky Mountain House area. These area models are discussed in 5.9.1.

5.6 Results of the Ratings Component

The 11 experts provided ratings on the extent of recreation activity, in terms of numbers of random campers, in their respective areas of jurisdiction. Grande Cache, the northern most area, contained lower average rating while the southern areas such as Calgary and Blairmore contained higher average ratings (Table 6). The highest average ratings were found in Rocky Mountain House and Blairmore areas. These results followed our expectations since southern areas are relatively close to the major population centres of Alberta and thus would be expected to attract large numbers of recreationists. Furthermore, these areas are located in close proximity to highly desired recreation areas such as the NPs, the Parks and PRAs and also contain a network of logging roads that facilitate access to the landscape for recreation. Grande Cache, the most northerly area, is furthest away from major population centres and thus attracts relatively few recreationists. In addition, motorized access to the Wilmore Wilderness Area that borders Grande Cache is also prohibited. These factors all lend to relatively few random campers (and hence low ratings) in the Grande Cache area.

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[4] It is noted that the mean value can be influenced by outliers. However, exploratory data analysis showed such outliers did not exist. Median values of the ratings were also derived; these median ratings were similar to the mean ratings. Hence in this study mean value ratings were used.

5.6.1 Local Indicators of Spatial Association (LISA)

The ratings data gathered in this component of the study is inherently spatial in nature. The importance of accounting for spatial relationships in data analysis was presented in Chapter 4. Accordingly it is possible to subject the data to exploratory spatial data analyses as described by Haining (1990) and others. While there are a number of ways to examine this, we focused on indicators of spatial association in order to examine hotspots or coldspots of random camping activity in the Region.

There are a variety of researchers who designed procedures to investigate spatial relationships. This research into spatial association, also referred to as spatial autocorrelation, in our case was motivated by the need to determine if the ratings display a non-random pattern over the study area. For example, are the random camping areas, and thus the ratings provided, in the East Slopes Region dispersed non-randomly across the landscape? To examine this question we used the test statistics described below. This description is based upon the discussion in Boots (2001).

Suppose the observed values of $x_i, i \in \{1,...,n\}$ are recorded at a set of n data sites or cells (indexed by i) in a study region or grid. Spatial autocorrelation arises when the values of x_i display a non random pattern over the grid. Non-randomness can imply that there is a clustering of like data values associated with cells. Thus, the measurement of spatial autocorrelation requires consideration of location and attribute information and is given by the cross product statistic represented as follows:

$$\Gamma = \sum\sum w_{ij} \, y_{ij} \quad (3)$$

where Γ is the cross product statistic, w_{ij} is a measure of the spatial relationship of data sites i and j and y_{ij} is a measure of their relationship in attribute space. These relationships can be defined in a variety of ways. However, like Chapter 4, the spatial relationship is defined here as 1st order geographic queen contiguity which was imposed on the spatial ratings data.

There are two measures of spatial association, global and local measures. The global measure assumes that processes that give rise to the data values are unchanged for the entire study region. However, for a large study area such as the East Slopes Region these ratings data may exhibit non-stationarity (Fortin 1999; Unwin 1996). Consequently, this limitation has led to the further development of local measures of spatial association (Anselin 1995). These local measures, commonly called local indicators of spatial association (LISA), focus on identifying variations in the pattern of spatial association within the study region. They also identify pockets of anomalous values, such as clusters of high (hot spots) or low values of association (cold spots).

Several versions of Γ have been developed, the most popular being the Geary *c* statistics and the Moran's *I*. Based on Boots (2001) the global Moran's *I* is given by:

$$I = (n/W)\left[\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}\, y_i\, y_j / \sum_{i=1}^{n} y_i^2\right] \qquad (4)$$

where $W = \sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}$, $y_i = (x_i - \bar{x})$, and the other variables are as defined previously.

The local Moran's I for cell i (I_i) arises from "localizing" the global measure. The localization comes from the definition of w_{ij}, which as mentioned above involved the 1st order queen's configuration for each cell in the grid. The formula for the local Moran's I is:

$$I_i = \left[y_i / \left(\sum_i y_i^2 / n\right)\right] \sum_j w_{ij} y_j \qquad (5)$$

The presence of local positive spatial autocorrelation would indicate a cluster of data values around i that would be similar to those of the neighbours of i, that deviate strongly (either positively or negatively) from the mean of x_i. Negative spatial autocorrelation describes the same situation except that the sign of the value at cell i would be opposite to that of its neighbours. However, if either x_i or the values in the neighbourhood are close to the mean data values, no spatial autocorrelation is indicated (Boots 2001).

The global Moran's I for the ratings data over the entire East Slopes Region was calculated using the spatial econometric software package GeoDa (Anselin 2003). The value of this statistic was 0.46 which indicates the presence, over the East Slopes Region, of positive spatial autocorrelation among the ratings. Local Moran's Is were similarly generated using GeoDa. Figure 4 shows a LISA map of local Moran's Is for the survey ratings. In this map statistically significant outliers are represented by the clustering of like and unlike values. For example, in Grande Cache where random camping activity is restricted to few cells, the ratings associated with these cells should be higher than ratings from the neighbouring cells. Thus, there are many outliers present. In contrast, in the southern areas where there is substantial random camping activity, higher rated cells are surrounded by similarly rated cells. Therefore, spatial outliers should be less common here. The mapping of the LISA values confirm these suggestions: the red regions which identify "hotspots" of random camping activity are largely restricted to the southern portions of the region while the blue areas identify "cold spots" where random camping is projected to be rare.

This map points out those areas of the province where random camping is likely an important activity for fire managers to worry about. Furthermore, this LISA map can also guide the managers in the allocation of fire fighting resources according to the values at risk framework. If human life is considered important, given resource constraints this map could be used by fire managers to better allocate fire fighting resources to high values at risk areas. This hotspots indicated in the LISA map suggest that southern areas should probably receive more fire fighting resources during wildfires due to the relatively high numbers of random campers than in the northern areas. In the northern areas, this map can be used to direct resources to the few high random camping locations rather than the entire landscape to minimize costs.

5.6.2 Relating the Ratings to Characteristics of the Cells

Results from the various ordered probit models that explain the experts' ratings as a function of the biophysical attributes of the landscape are provided in Table 7. The significant parameter estimate of σ in the second column of the Table suggests that incorporating respondent specific disturbance makes the model more robust. However, the signs and significance of the parameter estimates on the global and random effects models are similar.

The results show that the linear terms on the gravel road and truck trails all have positive and significant effect on the random camping ratings. These findings conform to our expectation of the positive impacts of road access on levels of outdoor recreation activity; increasingly dense road networks offer recreationists access and additional recreation opportunities for off-highway vehicle use to many areas of the landscape. The quadratic of the access variables were all negative and significant which suggests that as the density of road network increases it provides fewer opportunities for recreation. The linear paved road variable was positive and significant and was contrary to our expectations. This model result could be an artifact of data construction. A cell can have paved and unpaved roads some of which may attract random campers. In such cases, random camping would be associated with the presence of paved roads when in fact it is probably driven by the presence of unpaved roads. The unimproved road class had a negative and significant effect on the random camping activities for the global model and was negative but insignificant in the random effects specification. The negative sign was expected since this type of road is relatively primitive which may deter random camping access into the landscape.

The presence of water bodies, as measured by shoreline length, while positive, was insignificant. This is contrary to *a priori* expectation since interviews with land management personnel had revealed that water bodies often attracted random campers. However, McFarlane et al. (2003) surveyed some random campers in the East Slopes Region and found that the access to off-highway vehicle trails for recreation was one of the leading reasons for random camping. These findings suggest further study on the impact of water bodies on random camping activities.

The positive coefficient on Alberta parks and recreation areas was not as expected. Random campers tend to favour more rustic facilities and camp away from managed sites such as the parks and recreation areas (McFarlane et al. 2003). This result could be an artifact of data construction. An entire cell was considered to have a park or recreation area if any portion of that cell contained such area. It is possible that random camping activity in such a cell could be associated with a park or recreation area because random campers could utilize washrooms and other facilities provided by the managed campgrounds without paying. While this practice is not allowed, enforcement is typically not stringent due to budgetary issues by the responsible government departments.

The K100 variable was positive and significant. This finding was expected since a majority of random campers tend to be local residents (Mandrusiak 2003). This finding is consistent with other recreation studies (Brainard et al. 2001; Bateman et al. 1996) who found the population sizes in proximity to recreation areas to be a significant determinant of recreation demand.

The experience variable was significant but negative. This indicates that the respondents with greater years of experience tended to give lower ratings than respondents with fewer years of experience. Several speculations can be made concerning this finding. First, it is possible that the respondents with greater experience are better able smooth out the seasonal variations in random camping activities over a longer time frame and could have provided ratings based on this smoothed activity level. Second, changes in administrative responsibilities have meant that currently, forest patrols are conducted primarily by the Forest Guardians who tend to have fewer years of experience but are more likely to be exposed to random camping activities. This suggests that the guardians provided higher ratings for random camping activity.

5.7 The Spatial Pattern of Trips and their Value in the East Slope Region

Most economic analysis of recreation use trips as the unit of analysis. Its use is driven primarily by the need for economics to focus on human behaviour. Since trips are related to human behaviour changes in trip levels are useful in determining the economic welfare effects associated with factors that cause such changes. This underlying approach has led to the development of many valuation techniques such as the travel cost model and contingent behaviour methods which seek to evaluate changes in trips as the environment changes. For example, Vaux et al. (1984) determined the changes in forest recreation trips due to a fire burned landscape using the contingent valuation method. Others (Englin et al. 2001; McFarlane and Boxall 1998; Boxall et al. 1996; Englin et al. 1996) have used both travel cost and contingent behaviour methods in analyzing the effects of forest disturbances on recreation demand. In order to facilitate comparison with other recreation studies in this region, it was necessary to convert the ratings data to numbers of trips.

5.7.1 Estimation of Annual Trip Levels to Random Camping Sites

Deriving the numbers of trips taken for random camping required converting the ratings of the numbers of random campers into the numbers of trips taken by those campers. However, this derivation is challenging, particularly since there is a paucity of studies in the region that have explicitly incorporated random camping activity. One exception is McFarlane et al. (2003) who examined random camping in or near the Sunpine Forest Management Agreement (FMA) which occupies approximately 30% of the Rocky Mountain House area in the East Slopes Region (McFarlane et al. 2003; McFarlane et al. 1996). The conversion method outlined below is based largely on the data contained in McFarlane et al. (2003); the conversion of ratings to trips is illustrated using the Rocky Mountain House area. First, some background information and assumptions regarding the conversion method is outlined.

Aerial surveys conducted on the May long weekend over the Sunpine FMA estimated the numbers of random campers to be 6,000 individuals in that period. We assumed that the majority of random camping activity in a week occurs largely during the weekend or long weekend periods. This was validated in interviews with local Forest Officers and Guardians. It was also assumed that this intensity of random camping occurred in the rest of the Rocky Mountain House area and throughout the study period of 16 weeks (from the long weekend in May to the end of September)[5]. The extrapolation of the number of random campers from the Sunpine FMA to the rest of the Rocky Mountain House area can be represented as:

$$6{,}000 \text{ individuals} = 0.30\ RC_a^{RMH} \qquad (6)$$

where 6,000 is the numbers of random campers reported by McFarlane et al. (2003) for the one weekend in the Sunpine FMA, 0.30 is the proportion of Rocky Mountain House area occupied by the Sunpine FMA, and RC_a^{RMH} is the total number of random campers in the Rocky Mountain House area in week a. Rearranging (6) and solving for RC_a yields a total of 20,000 random campers in a week. Since there are 16 weeks in the study period, the total numbers of random campers over the season in the Rocky Mountain House area (RC_T^{RMH}) can be represented as:

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[5] A potential for overestimation of random camping trips using long weekend campers is noted.

$$RC_{T}^{RMH} = 20{,}000 \text{ individuals} * 16 \text{ weeks}. \qquad (7)$$

The estimated total number using this formula is 320,000 individuals.

The numbers presented above were used to calibrate the conversion from ratings to trips. First, the total numbers of people for three defined classes of ratings: low, average and high, were determined. The low case was represented by the numbers of people in the bottom end of the range for each rating; the average case was represented by averaging the low and high values specified for each rating; and the high case was represented by the numbers of people in the top end of the range for each rating. As shown in Table 8a the numbers of people for the low case, 324,000 matched closely to the estimated number derived from (7). Thus, the low case scenario was used in converting the numbers of people to numbers of trips for subsequent analysis.

The numbers of trips were determined using the average camping party size for random campers, which was 7.4 people reported by McFarlane et al. (2003:6). This party size is relatively high in comparison to sizes for PRAs and Parks in the Rocky Mountain House areas where the size was about 4.5 people per party (McFarlane et al. 2003). The larger random camping party size could be explained by the fact that random campers are attracted by the ability to camp in large groups as outlined in McFarlane et al. (2003). Thus, it was assumed that each random camping party consisted of two sub-parties and therefore, one random camping party involved at least two two-way trips to form the larger random camping party. Thus, the random camping trips taken to the Rocky Mountain House area can be represented as:

$$RCT_{T}^{RMH} = \left(\frac{Q_L}{C}\right) \times 2 \times 16 \qquad (8)$$

where RCT_T^{RMH} is the total number of random camping trips taken to Rocky Mountain House area over the season, Q_L is the number of people derived from the rating for the low case, and C equals 7.4, the average size of a random camping party. The right hand side is multiplied by 2 to account for the large camping party size and 16 to account for the weeks of study period. Solving (8) yielded approximately 87,000 trips (Table 8b).

Due to the lack of data for other study areas, the conversion method outlined above was used to derive the total number of random camping trips for the other areas in the East Slopes Region. The total random camping trips taken to the East Slopes Region, RCT_T^{ESR}, can be represented as:

$$RCT_T^{ESR} = \left(\frac{Q_L}{C}\right) \times 2 \times 16 \qquad (9)$$

where the variables and numbers are as defined above. The naïve assumption of the similarity of random camping party size across all the study areas and its impact on deriving total trips is noted. Furthermore, the sensitivity of derivation of random trips to low, average and high cases is noted (Table 8b). However, given the method outlined above, the trips derived from the low case were used in subsequent analysis. Thus, solving for RCT_T^{ESR} yielded an estimated 188,541 random camping trips in the entire East Slopes Region in a camping season.

5.7.2 Estimation of Annual Trip Levels to Managed Sites

The numbers of trips taken to managed sites (*MST*) annually were derived from several sources. McFarlane and Boxall (1998) and McFarlane et al. (1996) provide the actual trip levels for the PRAs in the Hinton, Edson and Rocky Mountain House areas. These trip levels are denoted MST_{PRA}^{HINTON}, MST_{PRA}^{EDSON}, *and* MST_{PRA}^{RMH} respectively. This information is summarized in Table 2. For the additional PRAs in other areas of the Region and the Parks for the whole Region visitation data from Alberta Community Development (2001) were used while backcountry campground (BC) data was obtained from Boxall et al. (2001) (Tables 1 and 3). The conversion of visitation numbers to estimates of trip numbers for these places was calculated as follows:

$$MST_k^A = \frac{OC}{3.08}, \qquad (10)$$

where MST_k^A refers to the total trips to a managed site of type k (k=additional PRAs, or Parks, or BC) in area A, OC is the number of occupied campsite nights defined "as one campsite occupied for one night" (Alberta Community Development 2001, p.7), and 3.08 is the provincial average length of stay (in nights) at a site (Alberta Community Development 2002a). This conversion likely understates total trips since only overnight trips and no day trips are accounted for. However, there is a lack of data for same day visits to conduct such conversion. Furthermore, other existing studies for the East Slopes Region (McFarlane and Boxall 1998; McFarlane et al. 1996) have also only used overnight trips in their analysis. Thus, the estimated total number of trips taken annually to the managed sites in the East Slopes Region (MST_T^{ESR}) can be represented as the sum of trips to PRAs, Parks and BCs in each of the six areas as follows:

$$MST_T^{ESR} = \sum_{A=1}^{6}\left[\sum_{PRA} MST_{PRA}^A + \sum_{Parks} MST_{Parks}^A + \sum_{BC} MST_{BC}^A\right] \qquad (11)$$

Solving for MST_T^{ESR} yielded an estimated 49,476 trips taken to all the managed and backcountry sites in the region for the 2003 camping season.

5.7.3 Estimation of Total Annual Trips taken to the East Slopes Region

The total trips taken to the East Slopes Region can be represented as follows:

$$TT^{ESR} = MST_T^{ESR} + RCT_T^{ESR} \qquad (12)$$

This formula yielded an estimated 238,017 trips taken for outdoor recreation in the East Slopes Region during the camping season in 2003.

This total estimate can be compared to the spatial econometric model prediction developed in Chapter 4 which was 8,720 trips. When this prediction was inflated to the provincial level approximately 3.4 million trips to the Region was estimated. However, one must note that the numbers of trips derived from (12) does not include day trips. It is thus difficult to compare the estimates from Chapter 4 for this Region with those presented in this chapter.

The total trips from (12) were mapped using ArcView to produce a spatial distribution of trips taken to random camping areas (Figure 5) and to managed sites in the East Slopes Region (Figure 6). A breakdown of the total trip level by recreation data layer and area in the Region is provided in Table 9. The areas with the highest proportions of trips are the Rocky Mountain House, Calgary and Blairmore areas which account for approximately 90% of the total trips taken to the East Slopes Region in 2003 (Table 9). This result was expected since these areas are in close proximity to some major population centres of the province and probably contain better access and recreation opportunities than the other areas in the Region. In contrast, there were relatively few trips taken to Grande Cache, Hinton and Edson areas. These results can be compared to the spatial distribution of predicted trips from Chapter 4 (Figure 7). This

Figure confirmed our proposition outlined above since the spatial econometric model also predicted relatively fewer trips in northern areas than southern areas.

Of the total trips taken to the East Slopes Region, approximately 80% were for random camping trips (Table 9). The majority of these trips occurred in southern areas (Figure 5). However, there are few studies of recreation in the Region with which to compare this estimate with. As noted in Chapter 3, few exceptions include McFarlane et al. (2003) and McFarlane et al. (1996) who suggest that in some parts of the Region random camping activity has increased over time. Williamson et al. (2002) also noted the prevalence of random camping in Canada. Like the random camping trips, the majority of trips taken to managed sites were also in southern areas (Figure 6). This is as expected since most of the recreation infrastructures are located in southern areas. These trips accounted for 20% of the total trips taken to the East Slopes Region (Table 9).

5.7.4 The Development of Economic Values Associated with Trips

Deriving an economic value of outdoor recreation trips has typically involved revealed and stated preference techniques such as travel cost and contingent valuation methods. The existing studies conducted in the Hinton and Edson areas by McFarlane and Boxall (1998) and the Rocky Mountain House area by Boxall et al. (1996) used zonal travel cost models to derive an average per trip consumer surplus value. As outlined in *5.4.1.2*, these values were similar across areas so an average value from these studies, $57 ($1996), was used. Boxall et al. (2001) also estimated a per trip consumer surplus value of $168 ($1996) for backcountry camping in Kananaskis Country in the Calgary area. This value was applied to the trips taken to back country campgrounds in the Calgary area when calculating the total consumer surplus.

Recreation valuation studies can be expensive to conduct and require detailed information on the origins and visitations levels by recreationists. It was not feasible to conduct these types of valuation studies for other study areas in the Region due to the lack of available data. In order to overcome these limitations, we turned to the benefit transfers approach.

5.7.4.1 Benefit Transfers Procedure

Benefit transfers is the process of "adapting existing models or value estimates to construct valuations for resources that are different in type or location from the one originally studied" (Smith 1993:7). This process is often used when it is impossible or impractical to undertake new studies. There are two broad approaches to benefit transfers: value transfer and function transfer. Value transfer uses benefits from a single site, or the average values of multiple sites, or some administratively set estimate to determine values at a new target site. Function transfer encompasses the transfer of a meta regression analysis function derived from several study sites, or the transfer of a benefit/demand function from a study site to the target site. The specifics of the new target site are adapted by function transfer from the study site to the target site. The latter approach, while conceptually sounder, requires a variety of information on site characteristics, user characteristics, and different spatial and temporal dimensions of recreation site quality and site choice (Rosenberger and Loomis 2001). Further discussion on these two approaches including, conditions for performing benefit transfer and its potential limitations are discussed by Rosenberger and Loomis (2001).

Given the limited data available for the East Slopes Region, a value transfer approach based on previously derived per trip consumer surplus of $57($1996) for all the random camping trips and the managed trips, except for backcountry camping was used. For the backcountry camping trips, per trip value of $168($1996) was used. The derivation of total economic value for the East Slopes Region can be represented as follows:

$$CS^{ESR} = TT^{ESR} \times V_{TRIP} \qquad (13)$$

where CS^{ESR} is the consumer surplus, or total economic value for the Region, TT^{ESR} is the total numbers of trips in the Region from (12), and V_{TRIP} is the economic value of a single trip.

5.8 Discussion

There were a total of 238,017 trips taken to the East Slopes Region in 2003 which generated an estimated consumer surplus of over $ 13.6 million (Table 9). This result has highlighted the importance of recreation in the East Slopes Region. A majority of these trips, and implicitly consumer surplus, were distributed in the Rocky Mountain House, Calgary and Blairmore areas (Table 9). These findings conform to our prior expectations of the spatial patterns of recreation activity in the East Slopes Region. The areas are in close proximity to the Rocky Mountains, some major population centres and contain a network of parks and recreation areas which provide numerous opportunities for outdoor recreation. Furthermore, networks of logging roads in these areas also offer access to many backcountry locations for recreation. Grande Cache is furthest away from major population centres. In addition, industrial activities and motorized access to the Wilmore Wilderness Area that borders the area is also prohibited. These factors all lend to relatively few recreationists in the Grande Cache area.

The research reported in this chapter also suggested that the majority of the trips taken to the East Slopes Region in 2003 occurred as random camping. The popularity of random camping has continued despite the establishment of PRAs by the provincial government. McFarlane et al. (2003) investigated the attitudes, characteristics and preference of random campers and found that lack of camping fees and free firewood, and opportunity for off-highway vehicle use, among others, were important to random campers. The importance of off-highway vehicle use is confirmed by the results of the model. It suggested that gravel and truck trail have positive influence on the level of random camping activity. Concerns related to the paved road variable have already been presented.

Despite some shortcomings this modeling exercise is valuable since it shows that the current fire management framework that restricts recreation values to managed sites ignores a substantial portion of recreation values. An explicit consideration of random camping would help fire managers improve allocation of fire fighting resources by better identifying areas of the landscape where suppression efforts are to be directed to protect the highest values at risk.

5.9 A Detailed Look at one Area in the Eastern Slopes Region: The Rocky Mountain House Area

The Rocky Mountain House area of this study corresponds approximately to the Rocky-Clearwater forest as defined in previous studies by McFarlane et al. (1996) and Boxall et al (1996). This area was chosen as a case study because it offers numerous opportunities for outdoor recreation in both managed sites and random camping locations. Furthermore, the previous study by McFarlane et al. (1996) contained recreation data for the PRAs in this area which makes it easier to incorporate random camping trips to derive a total picture of outdoor recreation activity in this area.

The information contained in this section is largely derived from previously presented material in McFarlane et al. (2003) and McFarlane et al. (1996). The Rocky Mountain House area lies between the town of Rocky Mountain House in the east, Banff and Jasper National Parks in the west, the Pembina River in the north and the Clearwater River in the south. The Rocky region is made up primarily of publicly owned forested lands that contain numerous industrial activities such as forestry, oil and gas and cattle grazing. The forest operations land base is widely used for outdoor recreation activities. The main driving route through this region is the Highway 11, the David Thompson Highway (Figure 8). This highway provides alternate route from the central area of the province into the foothills and Banff National Park. This route is increasingly popular because of scenic beauty, lower traffic volumes, well maintained roads and many campgrounds with lower fees than nearby National Parks. The network of logging roads in the region also offers access to remote locations and scenic recreational opportunities.

The major towns in this area include Drayton Valley, Sundre and Rocky Mountain House with combined population of 14,135 (Alberta Municipal Affairs 2001). Smaller communities include Caroline and Nordegg. The large urban centres of Edmonton and Calgary have populations of 648,284 and 860,794 respectively (Alberta Municipal Affairs 2001). They are both about 2-hour drive away from Rocky Mountain House. Red Deer with a population of 68,308 (Alberta Municipal Affairs 2001) is about 100 km from this area.

There are numerous opportunities for outdoor recreation in this area which support a variety of activities such as camping, hiking, hunting, fishing, off-highway vehicle use and horseback riding. These opportunities occur primarily in the one Park and the PRAs (Figure 8). Additional opportunities are found in the random camping areas. The Crimson Lake Provincial Park includes many amenities and services while the PRAs and random camping areas contain few amenities and services. Data limitation for other types of protected areas has been noted previously. The PRAs are located along major arterial routes such as the David Thompson (Highway 11) and provide semi-primitive recreation experience with rustic or basic services. The patrols conducted by the Forest Guardians have also identified the presence of substantial random camping activities in this area. Popular areas include proximity to some managed sites, along roads and water bodies. The random campers are engaged in a wide variety of recreation activities such as off-highway vehicle use, horse back riding and fishing (McFarlane et al. 2003).

5.9.1 An Area Specific Model of the Random Camping Ratings

Two ordered probit models for random camping in the Rocky Mountain House area were specified (Table 7). The first, area 1, uses the same biophysical attributes as the global model while for area 2, uses some different attributes (Table 6). The signs on the parameter estimates for the area models were not as expected. The K100 variable is highly significant but negative, contrary to expectations which have already been presented. However, McFarlane et al. (2003), in a survey of random campers conducted in this area, found that natural setting and solitude were two of the most important reasons for random camping. In this context, the negative coefficient on the population variable would be expected since proximity to population centres would make an area unattractive for random camping. The positive and significant coefficient on the campground variable is also not as expected. This result could be an artifact of data construction, concerns related to that have already been presented. The truck trail road class in area 1 was positive but insignificant, contrary to expectation since that type of road would be expected to provide opportunities for recreation.

5.9.2 The Spatial Pattern of Recreation for the Area

This pattern is derived from three sources. These are the trips taken to the Crimson Lake Provincial Park, trips taken to the provincial recreation areas and random camping trips. There were a total of 105,705 trips taken for outdoor recreation to the area (Table 9). Figure 9 shows the spatial distribution of these trips. The values derived using this analysis is compared to those derived in Boxall et al. (1996) for managed sites for this area. They estimated a consumer surplus of over $783,000 ($1996) while this present study, after including random camping trips, estimates the value to be over $6 million ($1996). The importance of random camping trips is highlighted by the fact that these trips account for over 80% of total trips taken to the area (Table 9). The incorporation of random camping into the analysis also fulfills one of the recommendations of Boxall et al. (1996) who cited the need to collect data from a wider spatial basis in the area. These results suggest that fire managers need to concentrate fire fighting efforts not only in managed sites but also random camping areas.

5.10 Future Research

It is unfortunate that more updated and comprehensive data were not available to conduct a more thorough outdoor recreation use analysis. Some data that exist are collected in an ad hoc manner which limits its usefulness. Information on random camping, while not formally collected, can be gathered from experts such as Forest Officers and Guardians who conduct patrols. A standardized method for random camping data collection could be conducted in conjunction with these patrols. The methods to collect data on managed sites have previously been outlined in McFarlane et al. (1996), although the expert ratings approach used in this present study could also merit attention.

There are several areas which warrant further research. First, the specification of cell size in the grid imposed on the study area can have a potential impact on the landscape attributes that drive random camping activity in that cell. A sensitivity analysis that experiments with varying cell sizes for high values random camping areas could be conducted.

Second, due to lack of recreational use data it is assumed that the per trip economic values for trips taken to all the regions of the East Slopes Region is similar. It is noteworthy that previous research (Boxall et al. 2001) on backcountry camping in the Calgary region revealed the per trip value to be substantially higher than the value used in the analysis. While the dissimilarity in the type of recreation activity between that study and this analysis is noted, it nonetheless illustrates the need for obtaining better data when deriving economic values of forest recreation.

Third, the assumption of similarities in random camping party sizes in all regions also warrants further investigation. Similar investigation is also warranted for visits to managed sites. A study such as this represents a first step in developing more comprehensive approach to including recreation concerns in a wildfire management framework. It also illustrates the type of information required to conduct this type of analysis in future studies. In particular, a systematic approach to collecting and updating outdoor recreation data by various public lands management agencies is needed. This chapter has contributed to the enhancement of Alberta's values at risk framework for fire management by better identifying high valued recreation areas in the East Slopes Region. This can enable fire managers to better allocate scarce fire fighting resources in addition to minimizing suppression costs.

Table 1. The numbers of visitors to the Provincial Parks in the East Slopes Region (Alberta Community Development 2001).

Provincial Parks	Number of visitors
Beauvais Lake	10389
Bow Valley	283974
Bragg Creek[a]	N/A
Canmore Nordic Centre	115855
Chain Lakes	11242
Crimson Lake	37821
Peter Lougheed	302008
Sheep River	59408
Spray Valley	268278
William A. Switzer	25633
Total number of visitors	1114608

[a] No data available

Table 2. The numbers of trips taken to selected Provincial Recreation Areas in Hinton, Edson and Rocky Mountain House areas (McFarlane and Boxall 1998; McFarlane et al. 1996).

Provincial Recreation Areas	Number of trips
Aylmer	52
Beaverdam	138
Blackstone	69
Brazeau East Canal	129
Brazeau Reservoir	587
Brazeau River	79
Brazeau West Canal	439
Brown Creek	144
Chambers Creek	721
Coal Spur	100
Crescent Falls	736
Dry Haven	207
Elk Creek	41
Fairfax Lake	383
Fickle Lake	754
Fish Lake	1778
Goldeye Lake	1032
Harlech	450
Horburg	101
Jackfish Lake	185
Lambert Creek	112
McLeod River	249
Medicine Lake	1118
Mitchell Lake	43
North Ram River	351
Pembina Fork	148
Peppers Lake	501
Prairie Creek	627
Ram Falls	904
Rock Lake	685
Saunders	53
Seven Mile	296
Shunda Viewpoint	90
South Fork	141
Strachan	383
Swan Lake	409
Thompson Creek	2128
Upper Shunda	531
Watson Creek	726
Whitehorse Creek	689
Total number of trips	18309

Note that the total numbers of trips listed here differ from those listed in McFarlane and Boxall (1998) and McFarlane et al. (1996) since these studies also included trips taken to some PRAs not in the East Slopes Region.

Table 3. The numbers of visitors to the backcountry campgrounds in Kananaskis Country the Calgary area from Boxall et al. (2001).

Backcountry campgrounds	Number of visitors
Aster	150
Big Elbow	126
Elbow Lake	549
Forks	638
Jewell Bay	115
Lillian lake	550
Lusk	48
Mt. Romulus	161
Point	889
Quaite	293
Ribbon Falls	323
Ribbon Lake	369
Three Isle	352
Three Point	15
Tombstone	324
Turbine	197
Wildhorse	2
Wolf Creek	6
Total	5108

Table 4. The number of survey respondents, average years of experience and their major responsibilities for the six forest areas in the East Slopes Region.

Area	Number of respondents	Years of experience (average)	Major responsibilities
Grande Cache	1	23	Wildlife officer
Hinton	3	24	Land use officer, district conservation officer
Edson	3	30	wildfire prevention, land use officer, fire guardian
Rocky	1	7	wildfire prevention, land use officer
Calgary	1	9	Wildfire prevention
Blairmore	2	8	wildfire prevention, enforce land use regulations

Table 5. Variable definitions and mean values (standard deviations in parenthesis) for the regression model explaining random camping activity in the East Slopes Region.

Label	Definition	Mean
Y	Ratings given by respondents (min = 1, max = 8)	1.69 (0.99)
RDGRA	Gravel road (km)	2.90 (4.49)
RDPV	Paved road (km)	0.95 (3.31)
RDUNIM	Unimproved road (km)	3.07 (5.24)
RDTR	Truck trail (km)	1.76 (3.41)
HPL	Shoreline of water body (km)	6.89 (10.71)
ABPRK	Alberta parks and recreation areas (1 = cell in or partially in a park, 0 = cell not in a park)	0.34 (0.47)
CMPG	Number of campgrounds in a cell	0.27 (1.01)
K100	Population within 100 km distance (in thousands)	237.59 (397.64)
EXP	Experience of respondents (in years)	13.30 (8.27)

Table 6. Summary of ratings for the intensity of recreation activity in the six forest areas in the East Slopes Region.

Respondent identification	Respondent's area of residence	Numbers of cells rated	% of the Region the area occupies	Rating			
				Max	Min	Mean	Standard deviation
1	Grande Cache	220	11	2	1	1.09	0.28
2	Hinton	289	15	5	1	1.08	0.36
3	Hinton	289	15	5	1	1.08	0.36
4	Hinton	289	15	5	1	1.08	0.36
5	Edson	136	7	5	1	2.07	0.68
6	Edson	136	7	5	1	2.04	0.59
7	Edson	136	7	5	1	2.04	0.59
8	Rocky Mountain House	748	37	8	1	1.53	1.09
9	Calgary	290	15	7	2	2.40	1.00
10	Blairmore	292	15	8	2	2.41	1.15
11	Blairmore	292	15	6	1	1.38	0.91

Table 7. Parameter estimates for the global, random effects and area ordered probit models explaining expert ratings of random camping trip intensity to 25 km^2 grid cells in the East Slopés Region and Rocky Mountain House Area.

Variables	Parameters (Standard errors)			
	Global model	Random effects model	Area 1 model	Area 2 model
Constant	-0.23278**	-0.77432**	-0.77016**	-0.69293**
	(0.06917)	(0.12774)	(0.08037)	(0.07383)
RDGRA	0.08308**	0.11762 **	0.09375**	0.08328**
	(0.01466)	(0.02267)	(0.02592)	(0.02585)
RDGRA2	-0.00358**	-0.00524**	-0.00369**	-0.00333**
	(0.00096)	(0.00133)	(0.00160)	(0.00159)
RDPV	0.04546**	0.05274**	0.28578**	0.31840**
	(0.01393)	(0.02524)	(0.11916)	(0.12245)
RDPV2	-0.00063	-0.00071	-0.04204**	-0.05027**
	(0.00038)	(0.00065)	(0.02014)	(0.02108)
RDUNIM	-0.01373**	-0.00822	-0.02222**	-0.02096**
	(0.00551)	(0.00907)	(0.00919)	(0.00907)
RDTR	0.05961**	0.07757**	0.04200	
	(0.01683)	(0.02884)	(0.02751)	
RDTR2	-0.00303**	-0.00408**	-0.00133	
	(0.00106)	(0.00182)	(0.00148)	
HPL	0.00041	0.00422	0.00532	0.00578
	(0.00253)	(0.00394)	(0.00387)	(0.00386)
ABPRK	0.00068	0.00464	0.32146**	
	(0.06188)	(0.10598)	(0.12655)	
CMPG				0.16097**
				(0.04093)
K100	0.00093**	0.00162**	-0.00158**	-0.00140**
	(0.00007)	(0.00021)	(0.00047)	(0.00045)
EXP	-0.01927**	-0.02492**		
	(0.00349)	(0.00554)		
μ_1	1.25651**	2.00779**	0.43951**	0.44233**
	(0.03832)	(0.06588)	(0.04240)	(0.04262)
μ_2	1.74575**	2.81393**	1.04350**	1.05117**
	(0.04894)	(0.08620)	(0.07145)	(0.07193)
μ_3	2.03893**	3.34999**	1.40299**	1.41574**
	(0.06060)	(0.10514)	(0.09517)	(0.09600)
μ_4	2.42748**	3.87598**	1.69020**	1.70563**
	(0.08380)	(0.11431)	(0.12228)	(0.12323)
μ_5	2.74054**	4.23107**	1.87577**	1.89110**
	(0.11334)	(0.14332)	(0.14617)	(0.14687)
μ_6	3.03552**	4.40233**	2.09457**	2.11383**
	(0.15808)	(0.15641)	(0.18395)	(0.18586)
Log Likelihood	-1996	-2800	-680	-676
χ^2	383	499	61	67
σ		1.50 **		
		(0.072)		

** Denotes significance at the 5% level or better

Table 8a. The conversion and calibration of the ratings to the numbers of random campers for the Rocky Mountain House area in summer 2003 using extrapolated Sunpine Forest Management Agreement data from McFarlane et al.(2003).

	Numbers of people		
	Low case[b]	Medium case[c]	High case[d]
Rocky Mountain House area	324608	483200	640000
Sunpine extrapolation[a]	320000		

[a] Extrapolation based on equation (5)

[b,c,d] Low case is represented by the numbers of people in the bottom end of the rating range for each rating, average case is represented by averaging the low and high values specified for each rating, and high case is represented by the numbers of people in the top end of the rating range for each rating

Table 8b. Sensitivity analysis of the conversion of ratings to the numbers of random camping trip in the six forest areas in summer 2003.

	Numbers of random camping trips		
Area	Low case[b]	Medium case[c]	High case[d]
Grande Cache	82	4108	8134
Hinton	2647	6054	9444
Edson	10819	36540	62180
Rocky	87715	129730	171261
Calgary	51624	113297	174746
Blairmore	35654	97730	159602
Total	188541	387459	585367

[b,c,d] Low case is represented by the numbers of people in the bottom end of the rating range for each rating, average case is represented by averaging the low and high values specified for each rating, and high case is represented by the numbers of people in the top end of the rating range for each rating

Table 9. The estimated distribution of trip numbers by type and the associated total consumer surplus values for six areas of the East Slopes Region in 2003.

Area	Estimated number of trips (% total trips) (% East Slopes Region total)			Total consumer surplus ($)
	Random camping[1]	Managed sites[2]	Total	
Grande Cache	82 (4.8) (0.04)	1606 (95.0) (3.2)	1688 (100.00) (0.71)	96216
Hinton	2647 (35.6) (1.4)	4798 (64.45) (2.01)	7445 (100.00) (3.13)	424365
Edson	10819 (87.84) (4.54)	1497 (12.15) (0.63)	12316 (100.00) (5.17)	702012
Rocky	87715 (82.94) (36.85)	18030 (17.05) (7.58)	105745 (100.00) (44.43)	6027465
Calgary	51624 (75.96) (21.69)	16341 (24.04) (6.87)	67965 (100.00) (28.55)	3967802
Blairmore	35654 (83.19) (14.97)	7204 (16.81) (3.03)	42858 (100.00) (18.00)	2442906
Total for the East Slopes Region	188541 (79.21)	49476 (20.79)	238017 (100.00) (100.00)	13660766

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[1] Converted from survey ratings, low case

[2] Trips taken to established network of Provincial Parks, Provincial Recreation Areas and backcountry campgrounds.

[3] $1996

Figure 1. The six study areas of the East Slopes Region displayed in 25 km^2 grids.

Source: Adapted from Alberta Sustainable Resource Development.

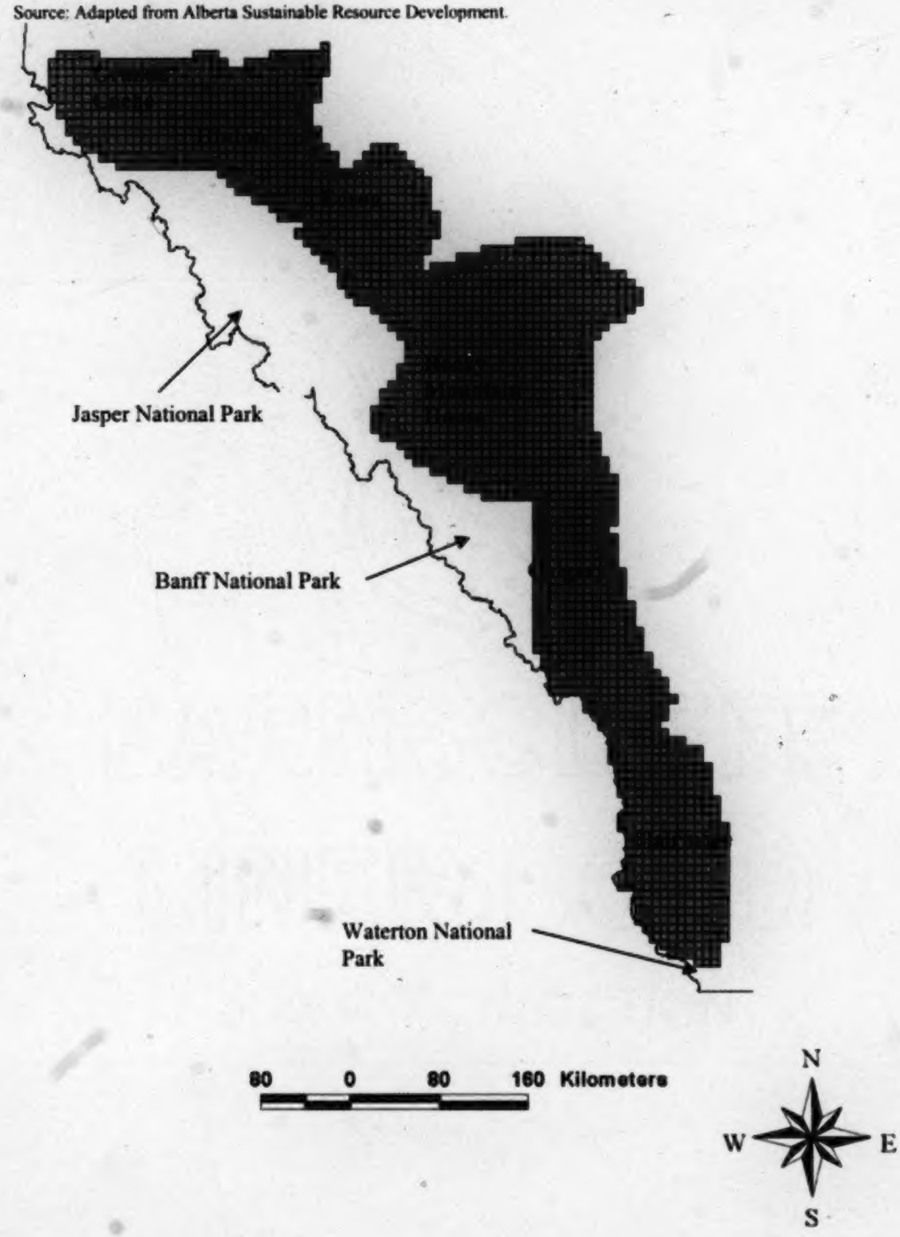

Jasper National Park
Banff National Park
Waterton National Park
80
0
80
160
Kilometers
N
W
E
S

Figure 2. The components of landscape over which outdoor recreation occur in the East Slopes Region of Alberta.

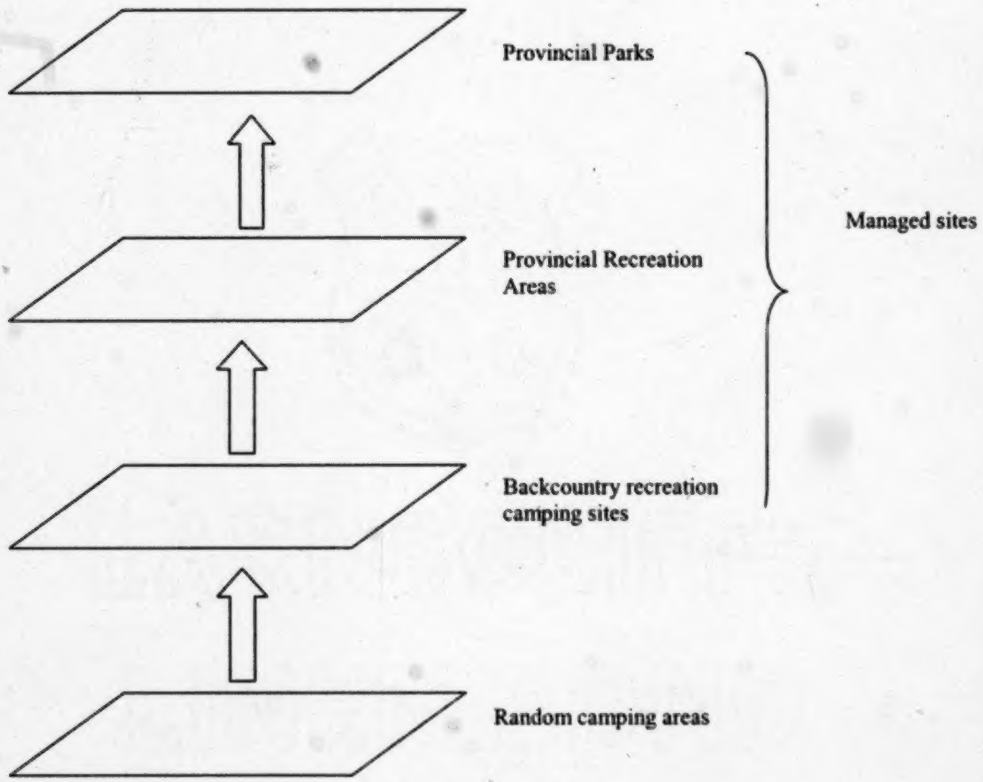
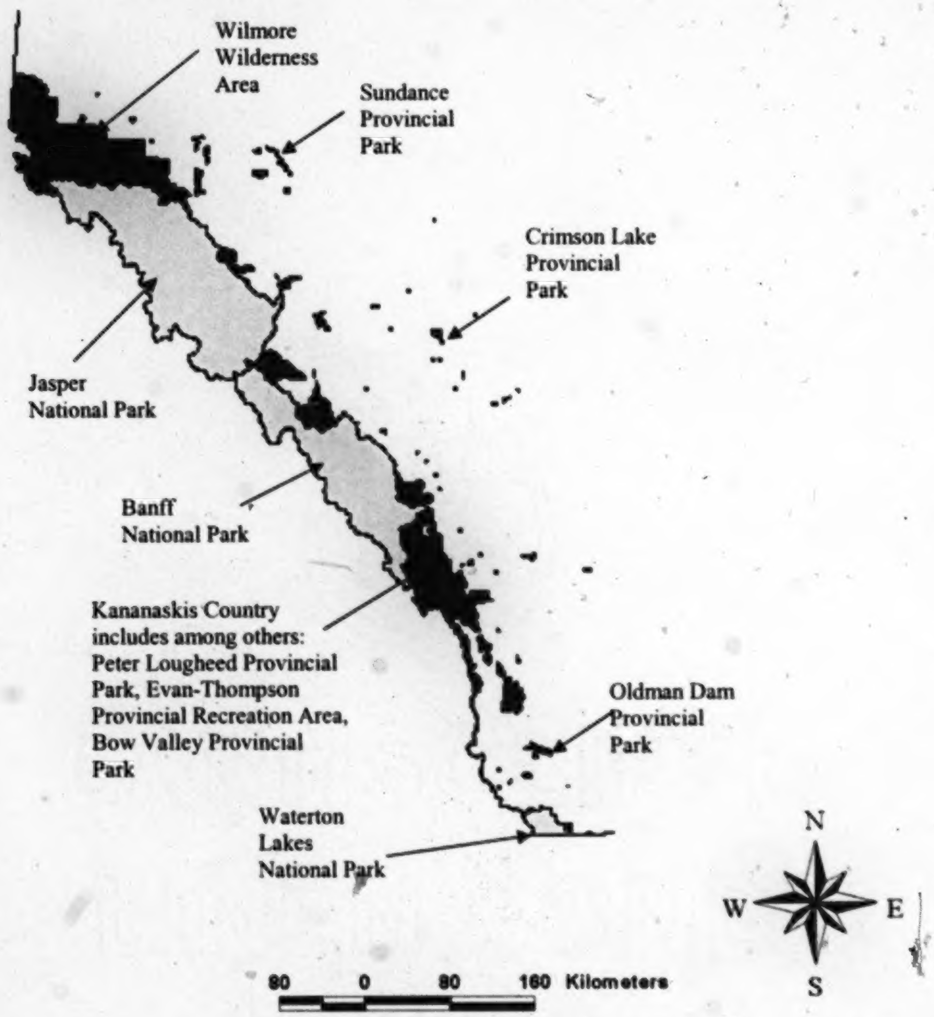

Provincial Parks
Provincial Recreation Areas
Backcountry recreation camping sites
Random camping areas
Managed sites

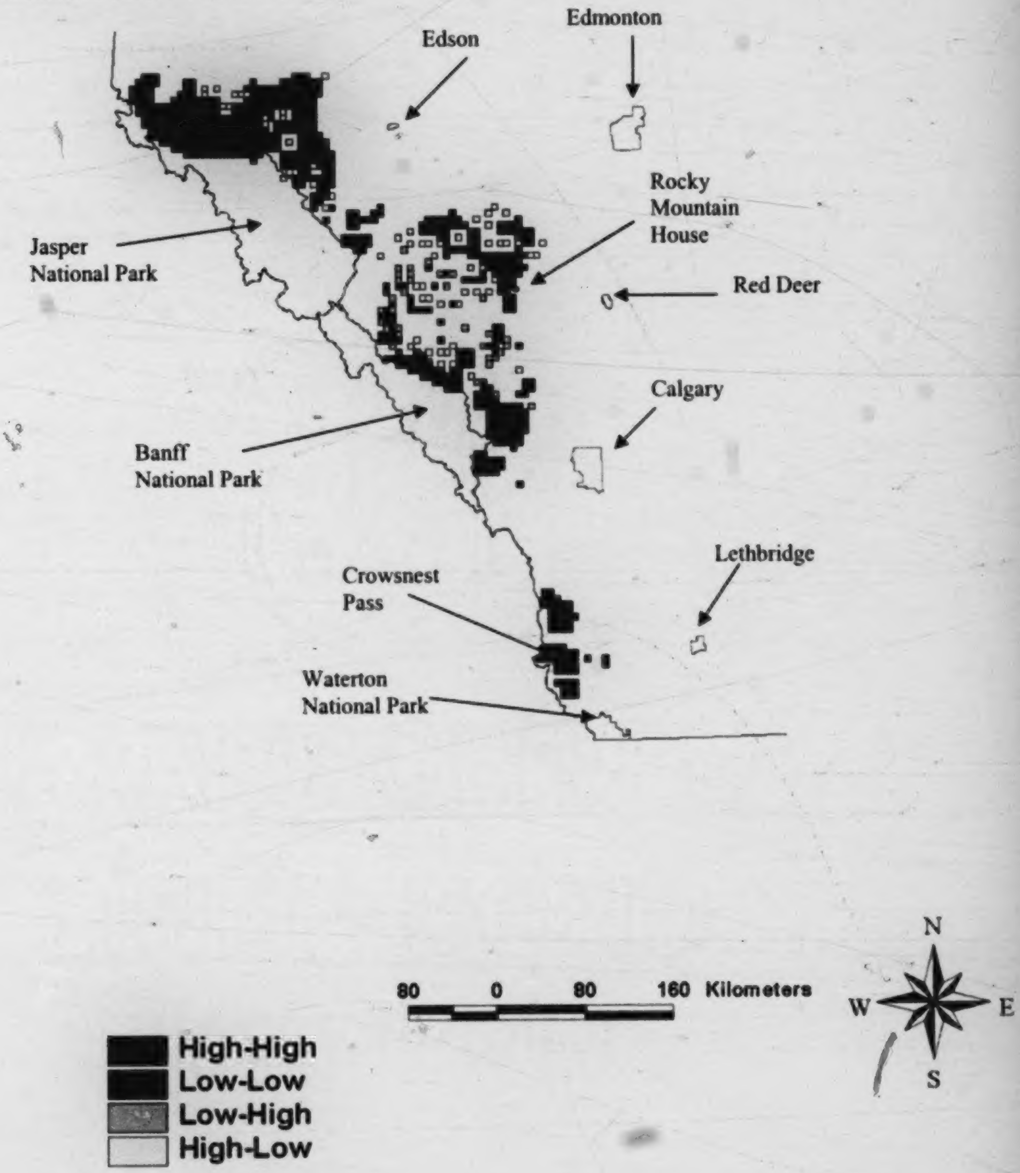
Figure 3. The spatial distribution of the National Parks, the Provincial Parks and the Provincial Recreation Areas in the East Slopes region.

Source: Adapted from Alberta Parks and Protected Areas Division. Note that only some of the parks and recreation areas are listed.



Wilmore Wilderness Area
Sundance Provincial Park
Crimson Lake Provincial Park
Jasper National Park
Banff National Park
Kananaskis Country includes among others: Peter Lougheed Provincial Park, Evan-Thompson Provincial Recreation Area, Bow Valley Provincial Park
Oldman Dam Provincial Park
Waterton Lakes National Park
N
W
E
S
80
0
80
160
Kilometers

Figure 4. Local indicators of spatial association (LISA) map for random camping rating in the East Slopes Region.



Source: Alberta Sustainable Resource Development

Edmonton
Edson
Rocky Mountain House
Jasper National Park
Red Deer
Calgary
Banff National Park
Lethbridge
Crowsnest Pass
Waterton National Park
80 0 80 160 Kilometers
N
W
E
S
High-High
Low-Low
Low-High
High-Low

Note: High-high and low-low locations suggest clustering of similar values whereas high-low and low-high indicate outliers.

Figure 5. The spatial distribution of random camping trips taken for outdoor recreation to 25 km^2 grids containing at least one trip in the East Slopes Region (low case).

Source: Alberta Sustainable Resource Development

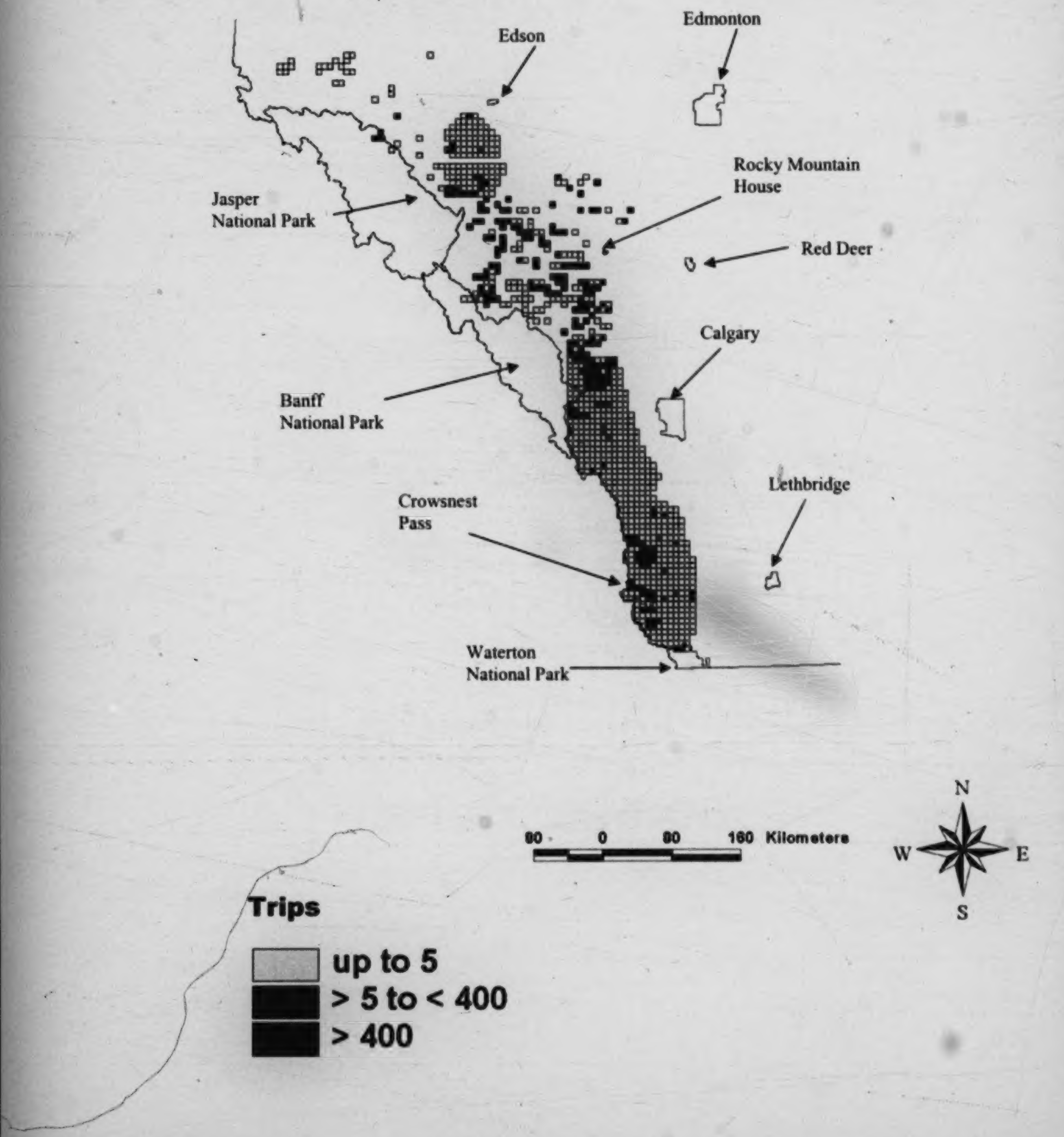

Edson
Edmonton
Rocky Mountain House
Jasper National Park
Red Deer
Calgary
Banff National Park
Lethbridge
Crowsnest Pass
Waterton National Park
80 0 80 160 Kilometers
N
W
E
S
Trips
up to 5
> 5 to < 400
> 400

Figure 6. The spatial distribution of trips taken to managed sites for outdoor recreation to 25 km^2 grids containing at least one trip in the East Slopes.

Source: Alberta Sustainable Resource Development

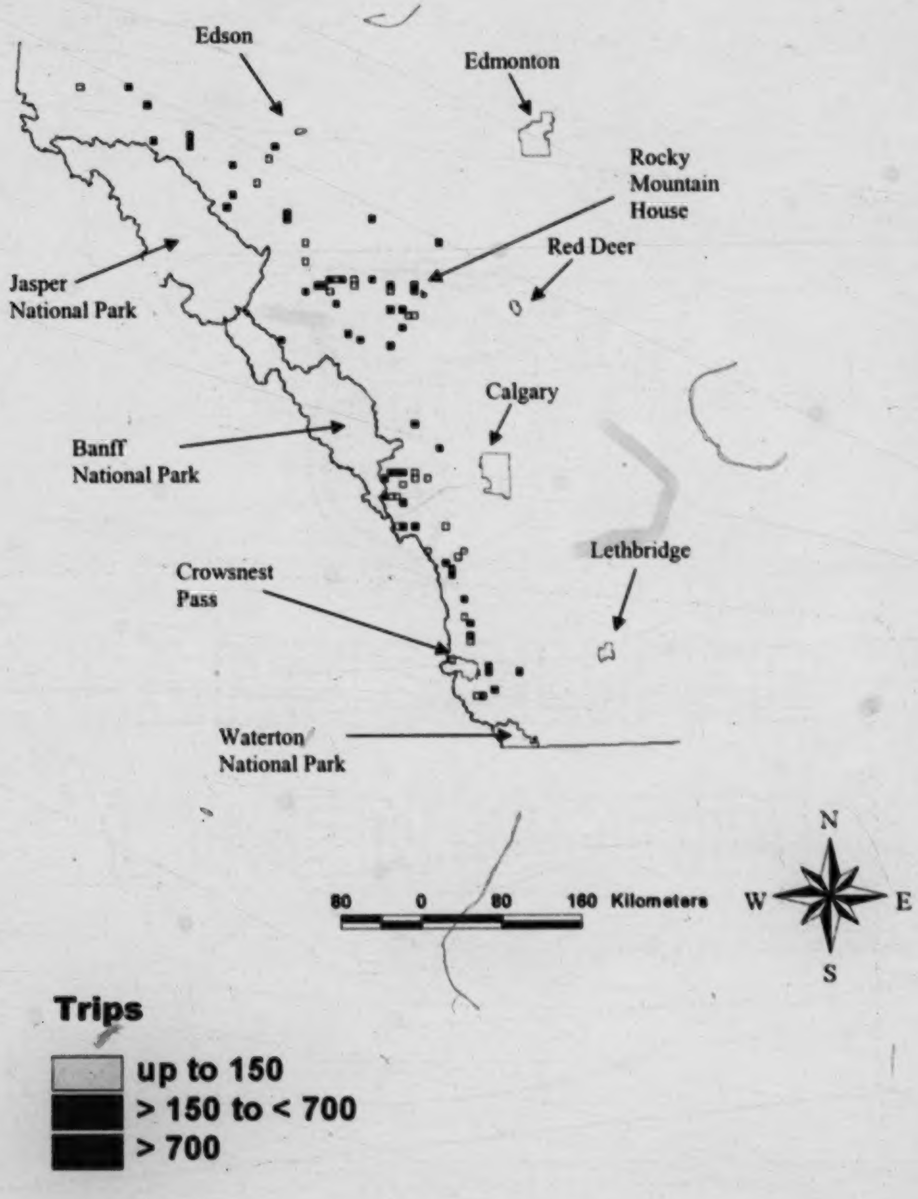

Edson
Edmonton
Rocky Mountain House
Red Deer
Jasper National Park
Calgary
Banff National Park
Lethbridge
Crowsnest Pass
Waterton National Park
80
0
80
160 Kilometers
N
W
E
S
Trips
up to 150
> 150 to < 700
> 700

Figure 7. A comparative view of the spatial distribution of outdoor recreation trips taken to the East Slopes Region.

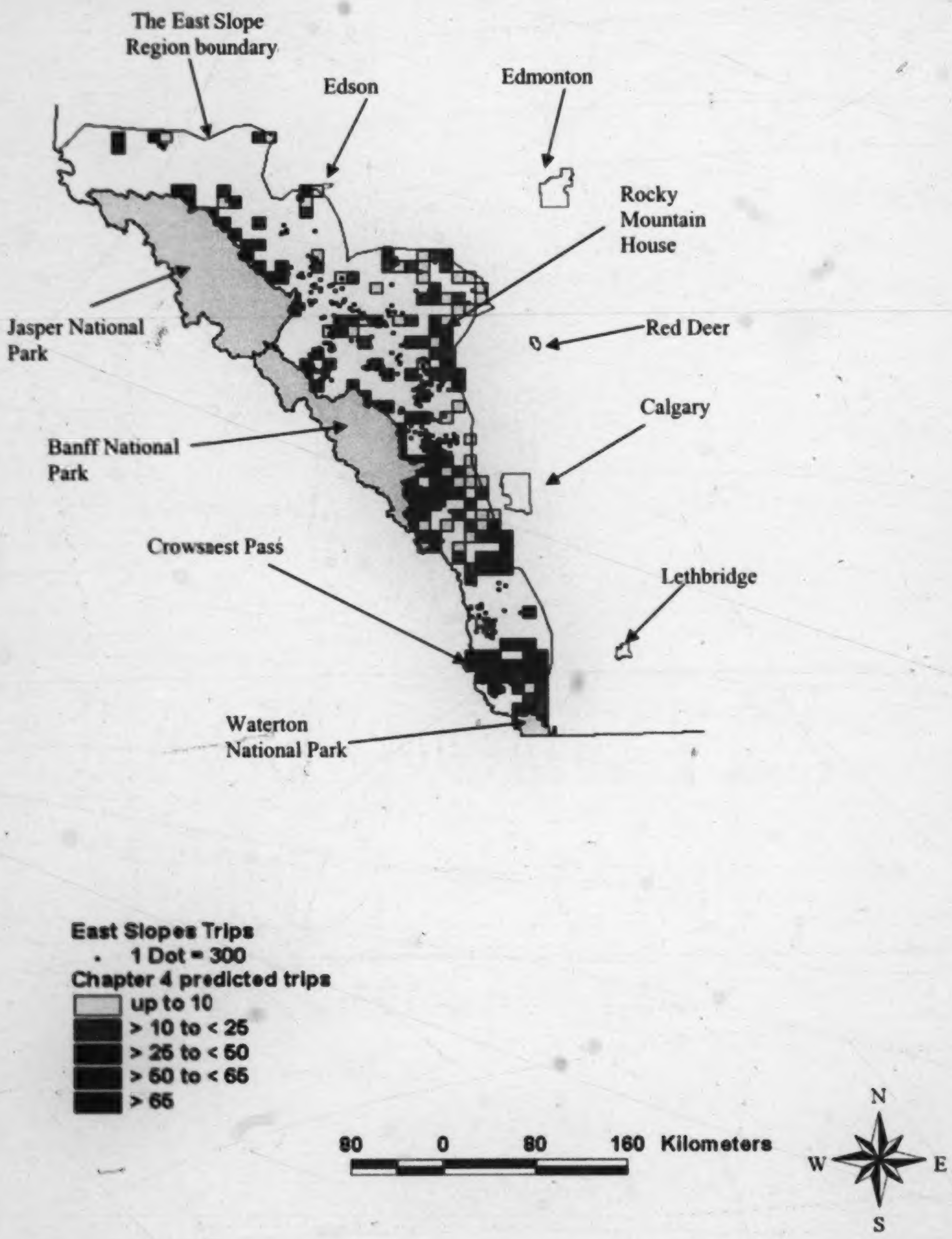
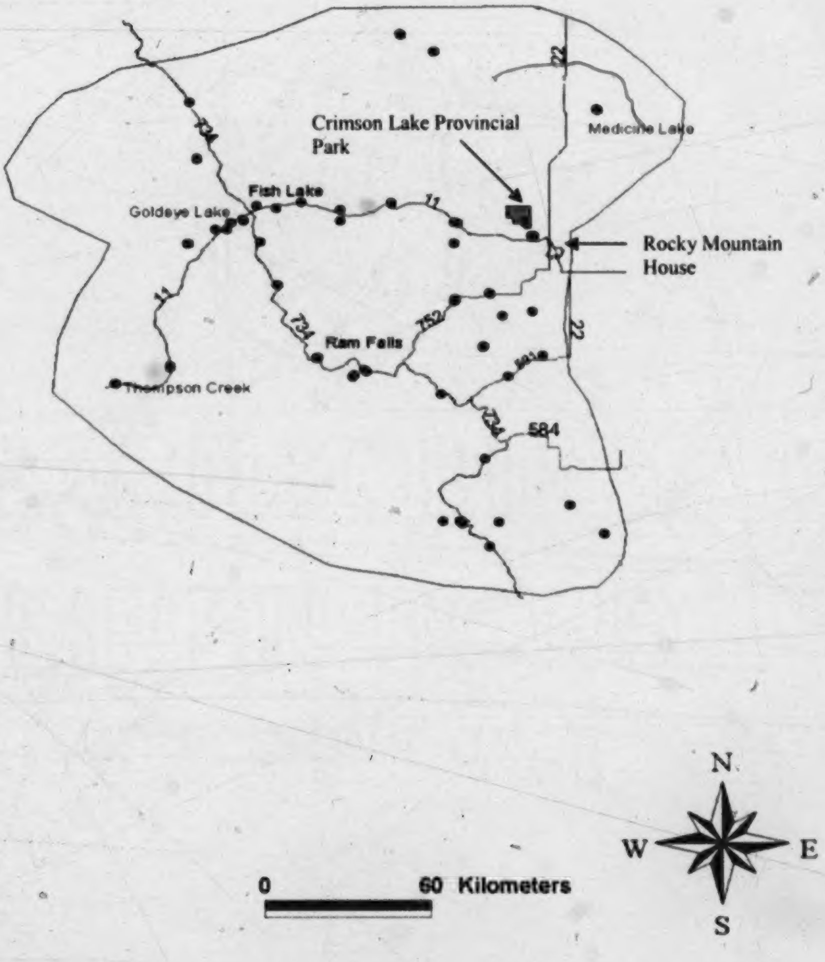

The East Slope Region boundary
Edson
Edmonton
Rocky Mountain House
Jasper National Park
Red Deer
Calgary
Banff National Park
Crowsnest Pass
Lethbridge
Waterton National Park
East Slopes Trips
1 Dot = 300
Chapter 4 predicted trips
up to 10
> 10 to < 25
> 25 to < 50
> 50 to < 65
> 65
80 0 80 160 Kilometers
N
W
E
S

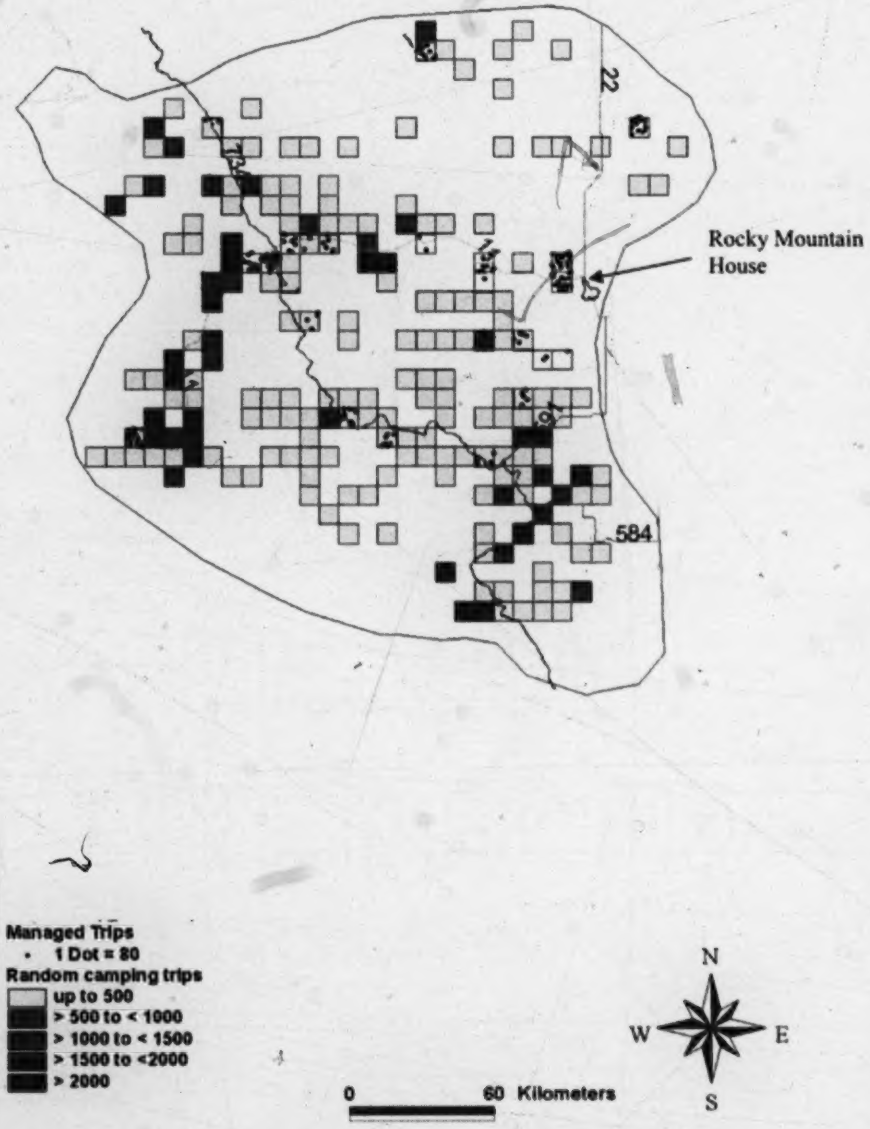
Figure 8. The spatial distribution of Provincial Park, Provincial Recreation Areas, and major roads located in the Rocky Mountain House forest area.

Source: Adapted from Alberta Parks and Protected Areas Division, Alberta Sustainable Resource Development


734
22
Crimson Lake Provincial Park
Medicine Lake
Fish Lake
11
Goldeye Lake
Rocky Mountain House
752
734
11
Ram Falls
22
Thompson Creek
734
584
0
60 Kilometers
N
W
E
S

Note: The five most visited PRAs from McFarlane et al. (2003) are shown.

Figure 9. The predicted spatial distribution of trips taken to managed sites and random camping area displayed in 25 km^2 grids in the Rocky Mountain House forest area.


22
Rocky Mountain House
584
Managed Trips
• 1 Dot = 80
Random camping trips
up to 500
> 500 to < 1000
> 1000 to < 1500
> 1500 to <2000
> 2000
N
W
E
S
0
60 Kilometers

Chapter 6
Conclusions

6.1 Review of Research Objectives

The overall goal of this thesis was to develop some approaches to explicitly account for recreational values in forest fire management. Specifically, the research objectives were to: i) Develop spatially explicit indicators and models of forest recreation to be incorporated into a fire management zoning scheme or values-at-risk map (VARM) for Alberta; and ii) Predict spatial patterns of recreation activity that are useful in allocating resources for protecting valued recreation areas and evacuation of visitors from those areas in the event of fire.

These objectives were fulfilled by examining recreation data for the province of Alberta. Specifically, the forest areas for which the Alberta Sustainable Resource Development (SRD) has a mandate for fire management and other areas were examined. Two primary sources of data were used. First, the 1996 National Survey on the Importance of Nature to Canadian (NSINC) which has recreation data for the whole province was used. Second, a compilation of existing recreation data focusing on the Eastern Slopes Region which is a highly sought region in the province for outdoor recreation was used. These data were supplemented with expert ratings of recreation activity in a form of camping in public land called random camping. The purpose of using the expert ratings was to investigate and highlight the presence of substantial random camping in addition to recreation occurring in the managed sites.

6.2 Summary of Findings

At present, the current fire management framework does not explicitly include recreation values. Recreation use is assumed to be represented by the presence of publicly provided infrastructure such as picnic tables, shelters, fire pits etc. The economic value associated with recreation is assumed to be reflected through the replacement cost of this recreation infrastructure in the event of loss due to fire. Recreation economic values, however, should also include the value associated with participating in the activity, and this participation may be or may not be associated with the provision of recreation infrastructure. This speculation was confirmed by the results obtained in Chapters 4 and 5.

Chapter 4 showed that although the recreation infrastructure is spatially dispersed across Alberta, the distribution of activity is not related to the infrastructure provision pattern. For example, relatively few trips were made to northern Alberta. Of the 13.2 million trips taken by Albertans in 1996, approximately 70% of the trips occurred in southern Alberta. Some of the highly sought after recreation areas in the province included the East Slopes Region. Some of the highest ranked cells, in terms of trips taken, were around Edmonton in the south. In the north, highest ranked cells were associated with human settlements like Peace River and Grande Prairie.

In Chapter 5 the comparison of the spatial pattern of trips to managed sites and random camping in the East Slopes Region further highlighted the importance of recreation participation and not necessarily recreation infrastructure when determining recreation economic values. The results showed that there were 230,017 trips taken to the Region in 2002 of which approximately 80% were for random camping activities which are not associated with publicly provided recreation infrastructure. These results further highlight the need to incorporate recreation participation in addition to the costs of infrastructure in the fire management framework.

6.3 Limitations of the Study

It is unfortunate that the most comprehensive data available to conduct analyses such as this are rudimentary in nature and out-dated. The 1996 NSINC information is the only available data on recreation trips throughout the province that could be found to conduct this analysis. Furthermore, the inaccuracies involved in the spatial referencing of this information will require a more thorough analysis of spatial econometric concerns than reported here.

The presence of high proportion of zero trips in these data also warrants investigation of alternative econometric techniques. In particular, the zero inflated tobit and poisson models merit some attention. Unfortunately, advances in spatial econometric techniques have not occurred with limited dependent and qualitative dependent regression frameworks.

The NSINC also contained some notable limitations such as soliciting trip information on only the most frequented sites. It is possible that Albertans are engaged in recreation activities in other sites as well. The conversion of random campers to trips merits further attention. In particular, the potential to bias the numbers of trips based on random campers in one particular area is noted. The assumption of similarity of random camping party size and per trip consumer surplus value across all the areas of the East Slopes Region is also limiting. These assumptions are likely to bias the numbers of trips and the consumer surplus values that were estimated.

6.4 Policy Implications

An explicit consideration of recreation values is advantageous in that these values are closely linked to the presence of recreationists, and implicitly human life. This is considered the highest values at risk from fire in Alberta's values at risk framework in fire management. Therefore, during fire events, directing resources to high value recreation areas can fulfill a fire management goal of protecting highest values at risk, as well as identifying areas of the landscape where the suppression efforts and/or evacuation efforts are to be directed. This can help minimize the risk from fire to the high valued areas in addition to minimizing fire suppression expenditures. For example, the information provided in Chapter 4 showed that there were no recreation infrastructures in the area of the Chisholm fire, and relatively few recreation trips were taken to the area. From a recreation value perspective, limiting fire fighting resources to the evacuation of these few recreationists rather than extensive fire suppression effort is probably warranted. This can help minimize the fire suppression expenditures as well as free scarce fire fighting resources for high value recreation areas, such as the East Slopes Region.

6.5 Recommendations

Throughout this study, we noted the lack of consistent, comprehensive, and up to date sources of recreation data to conduct this type of analysis. The most comprehensive and consistent data available at a provincial scale was the 1996 National Survey on the Importance of Nature to Canadians (NSINC). This database is almost 10 years old. While a variety of other data exist, they are not currently constructed or collected in a consistent manner which prevents their use in a project of this nature. In light of these data gaps the following recommendations are made:

i) Redesign and collect mandatory camping permits from the Provincial Parks, the Provincial Recreation Areas, backcountry campgrounds, and other managed recreation sites.

Boxall et al. (1996) showed how a few modifications to the existing camping permits could be used to collect data for this type of analysis. Their modifications solicited additional data including the numbers of people in the camping party, the frequency of trips to the campground in the past and the registrants' postal code of origin. They noted that mandatory registration, while primarily used as an accounting system for campground fees, can also be used as an inexpensive data collection system to assist management efforts. In the case study Boxall et al. (1996) examine, they were able to estimate economic values associated with participation in camping at managed sites in a specific area of the province. Very few of the methods currently used by parks managers in Alberta can be used for this purpose at present.

ii) Enhance the permit data by periodically collecting spatial data on recreation use.

The importance of accounting for space in outdoor recreation has been demonstrated by this study. However, accurately collecting the spatial extent of recreation activity can be challenging. One possible method of collecting such data would be to intercept recreationists and collect from them, in addition to the standard permit question, areas where they engaged in recreation activity. While this method of data collection is relatively more expensive than permit data, collecting spatial information allows land managers to determine the spatial extent of recreation activity. The data collected from the permits assume recreation activity to be tied to some specific infrastructure such as campgrounds when in fact recreationists are free to move about the landscape. The information on the spatial distribution of recreationists can also be used to allocate fire fighting resources.

iii) Collect consistent random camping information from Forest Officers and Guardians using standardized survey instruments.

Many of the Forest Officers and Guardians in the local Sustainable Resource Development (SRD) offices who conduct patrols of the public forest lands are knowledgeable about random camping activity in their area. These personnel can be valuable sources of information since no other method currently exists to formally collect such data in a consistent manner. Interviews with Officers in some areas revealed that in the past, random camping information was collected and updated in their area. In order to overcome the inconsistent and ad hoc nature of random camping data collection procedures, a standardized survey of the Officers and Guardians could be conducted periodically. The survey instrument and use of the map outlined in Chapter 5 merits further attention. This type of survey would be by far the least expensive method of collecting random camping data for SRD. In addition, portable GPS units which are relatively inexpensive and easy to use could be used to spatially reference random camping areas in a more accurate manner and develop GIS recreation layers (Fig 2, Chapter 6) in a consistent manner.

iv) Increase inter-agency co-operation in the management of recreation landscape.

Currently, Community Development has jurisdiction over much of the publicly provided recreation sites, including periodic survey of visitors. However, many of these sites are often located in areas where Sustainable Resource Development (SRD) has forest management responsibilities. In fact, some these sites were historically managed by SRD. The growing importance and impact of forest recreation would suggest that SRD take a role in managing these sites.

6.6 Future Research

The development and mapping of recreation information as conducted in this study connotes information that is typically viewed as static and rudimentary. For example, using the spatial information in assessing the effects of fire on recreation one might assume that in cases where a cell burns, the recreational value contained in that cell becomes $0. This may not be the case for a number of reasons. First, as previous research suggests (Englin et al. 1996) recreationists probably have varying preferences for burned landscapes. Some recreationists' activities may be affected by fires (e.g. fishing and hunting), or in some cases may be enhanced by it (e.g. wildflower gathering, mushroom picking). This suggests that fire may affect recreational activities in different ways.

Second, while fire is a natural disturbance in the forests of Alberta, forests recover from fire. This suggests that recreation values may not be "lost" due to fire, but recover in much the same way the forest does. This indicates a number of interesting dimensions researchers can pursue. One is the understanding of intertemporal recreational amenities in which recreation values change as the forest ages, burns and recovers or grows back following fire (Englin et al. 1996). Another is assessing the movements of recreationists across forested landscapes as portions of that landscape burn. In this sense recreation values are not lost, but are maintained through recreationists visiting other parts of the forest in response to a fire in their favourite areas.

In addition, in this study the lack of data forced the use of benefits transfer procedures to assess recreation values. We expect that different areas of the province may have different recreation values. Thus, forcing all forms of recreation in all areas of the province to have the same value is not accurate. This oversimplification points to economists utilizing available data or forthcoming data arising from new data collection systems to develop regional specific recreation values in the province. McFarlane and Boxall (1998) and Boxall et al. (1996) provide a good start on this by developing a data collection system in two areas of the Eastern Slopes Region and applying a consistent valuation model to each.

Finally, the spatial econometric analyses in this study were rudimentary in that a number of substantive data issues were not fully addressed. Spatial econometrics is a rapidly developing field and one can expect the future development of models to address a number of the limited dependent variable issues that typically arise in recreation demand analysis. One of particular relevance to this study will be the development of spatial count data models (e.g. Poisson) which if available may provide a more accurate picture of the spatial pattern of recreation across the province presented in Chapter 4.

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Appendix A. Parameter estimates (standard errors) for two out of sample Tobit models.

	Model 1	Model 2
Constant	-9.56 (7.623)	-2.78** (0.2973)
HPL	0.00750** (0.003752)	0.00863** (0.003496)
HPL2	-0.000018 (0.000015)	-0.000025* (0.000015)
RD	0.014099** (0.002797)	0.016023** (0.002126)
FORST	-0.001067 (0.002489)	-0.003538* (0.001908)
CMPG	0.1568** (0.066014)	0.1946** (0.060994)
P70KT	0.024139 (0.017436)	
P70KT2	-0.000358* (0.000235)	
P120KT		-0.002113 (0.001982)
σ	99.69	100.82
LLF	-402.3	-403.423

** Significant at 5% , * Significant at 10%

Appendix B. Parameter estimates (standard errors) for six out of sample OLS models.

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	0.908 (3.703)	1.364 (3.706)	1.364 (3.706)	1.871 (3.707)	0.949 (3.707)	7.132 (4.725)
HPL	0.086 ** (0.034)	0.090** (0.034)	0.090** (0.034)	0.095** (0.034)	0.065 (0.089)	-11.369 (17.618)
HPL2						45.315 (37.676)
HPL3						-23.153 (19.786)
RD	-0.155** (0.068)	-0.154** (0.068)	-0.154** (0.068)	-0.163** (0.068)	0.00002 (0.001)	-37.716** (12.800)
RD2	0.002** (0.0004)	0.002** (0.0003)	0.002** (0.00003)	0.002** (0.00003)	-0.155** (0.068)	40.658** (10.881)
RD3						-5.502** (2.667)
FORST	-0.059** (0.030)	-0.061** (0.030)	-0.061** (0.030)	-0.054* (0.030)	-0.002** (0.0001)	-0.060 * (0.031)
CMPG	5.405** (0.878)	5.364** (0.876)	5.364** (0.876)	5.805** (0.863)	-0.058* (0.030)	5.473** (0.878)
P70KT		-0.034* (0.018)	-0.034* (0.018)	-0.032* (0.018)	-5.413** (0.878)	
P70KT2		0.00004** (0.00001)	0.00004** (0.00001)	0.00004** (0.00001)		
P120KT	-0.003 (0.002)				-0.002 (0.002)	-0.003 (0.002)
SETMTN	16.889** (6.113)	16.819** (6.117)	16.819** (6.117)		16.965** (6.121)	16.881** (6.121)
R square	0.085	0.080	0.080	0.085	0.085	0.088
LLF	-11810	-11808	-11808	-11811	-11810	-11808

** Significant at 5% , * Significant at 10%

[a] HPL and RD are in hundreds of kilometres

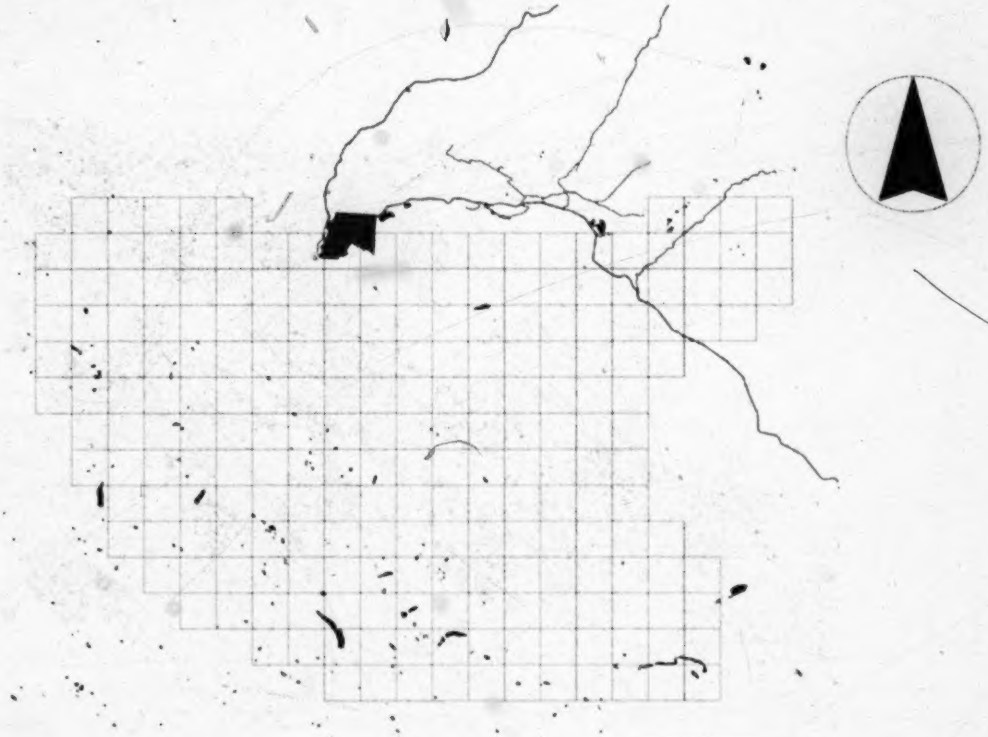
Appendix C. Parameter estimates (standard errors) for the cubic functional form explaining recreation trips to 100 km^2 cells in southern Alberta.

Variables	OLS
Constant	7.13
	(4.73)
HPLH	-11.36
	(17.62)
HPLH2	45.32
	(37.67)
HPLH3	-23.15*
	(19.79)
RDH	-37.32 **
	(12.79)
RDH2	40.65**
	(10.88)
RDH3	-5.51 **
	(2.66)
FORST	-0.0602**
	(0.0309)
CMPG	5.47**
	(0.078)
P120KT	-0.0025
	(0.0024)
SETMTN	16.88**
	(6.12)
LLF	-11808
R^2	0.084

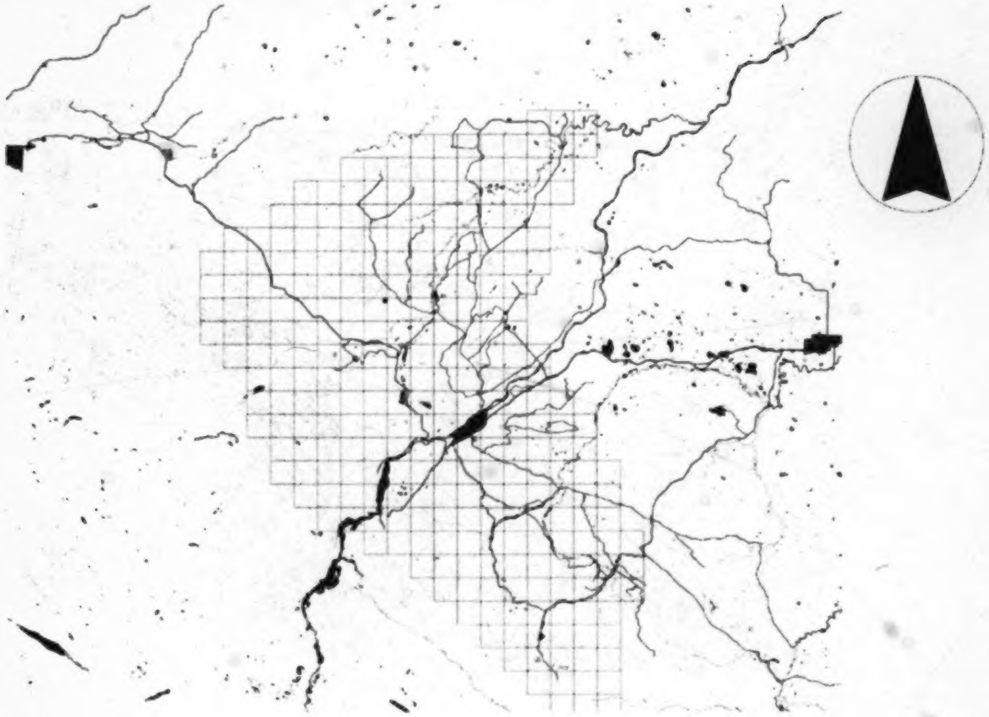
** Significant at 5% or better

Note that HPL and RD variables are in hundreds of kilometres.

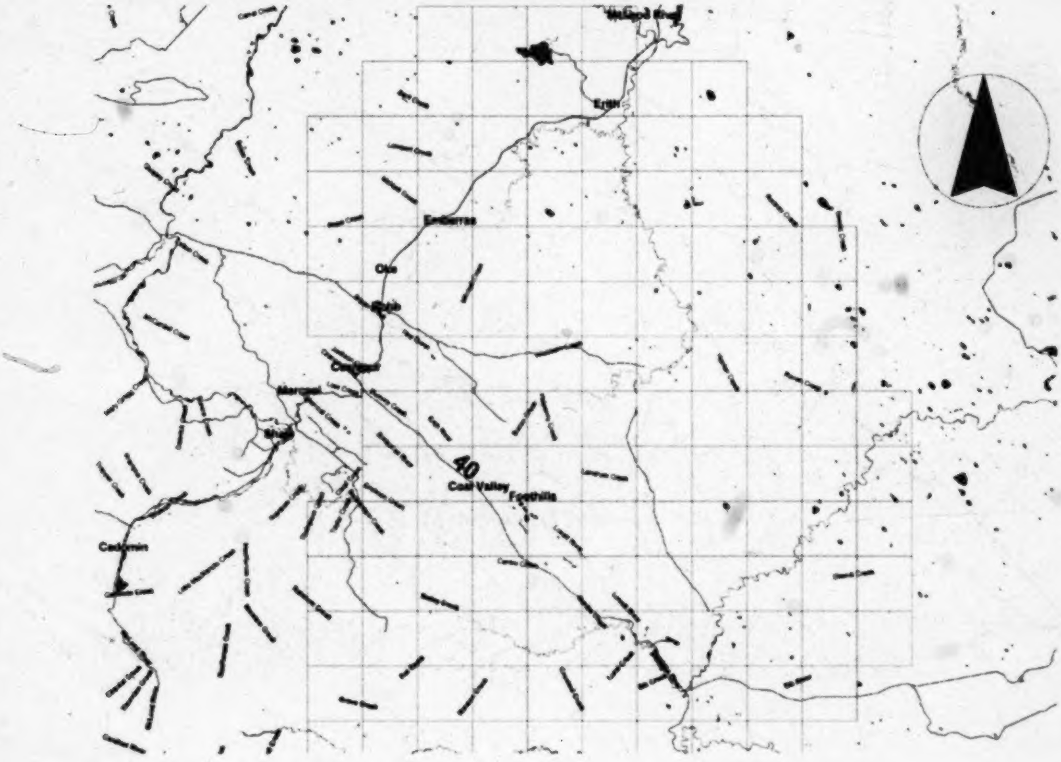
Appendix D. The Grande Cache Area displayed in 25 km^2 grids.



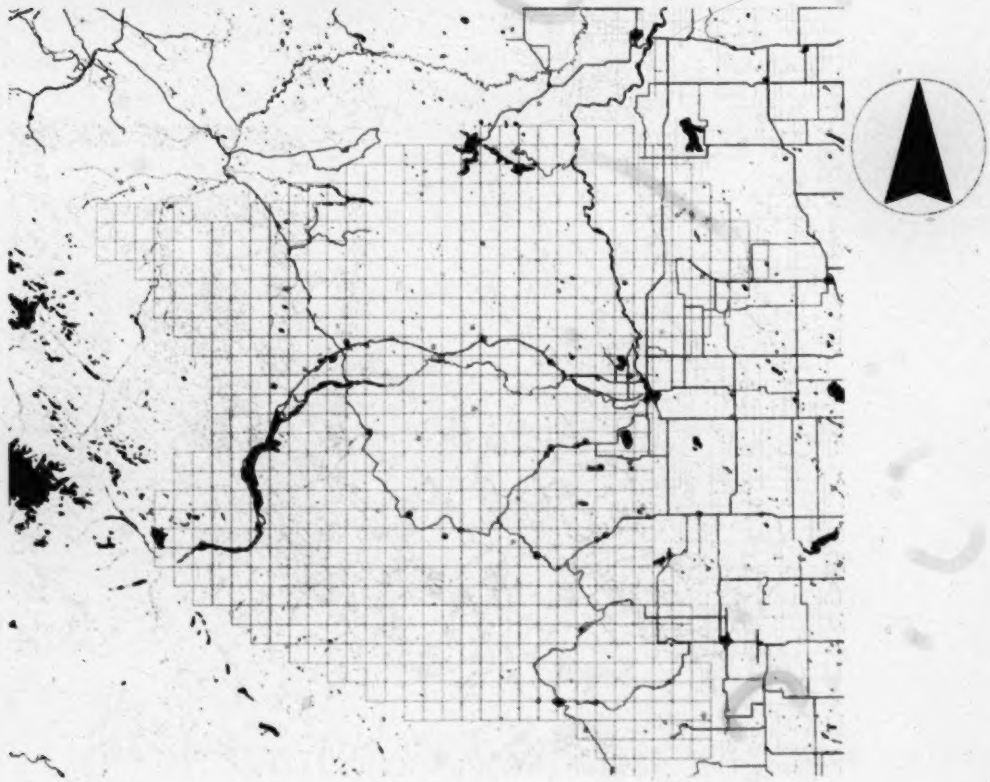
Appendix E. The Hinton Area displayed in 25 km^2 grids.



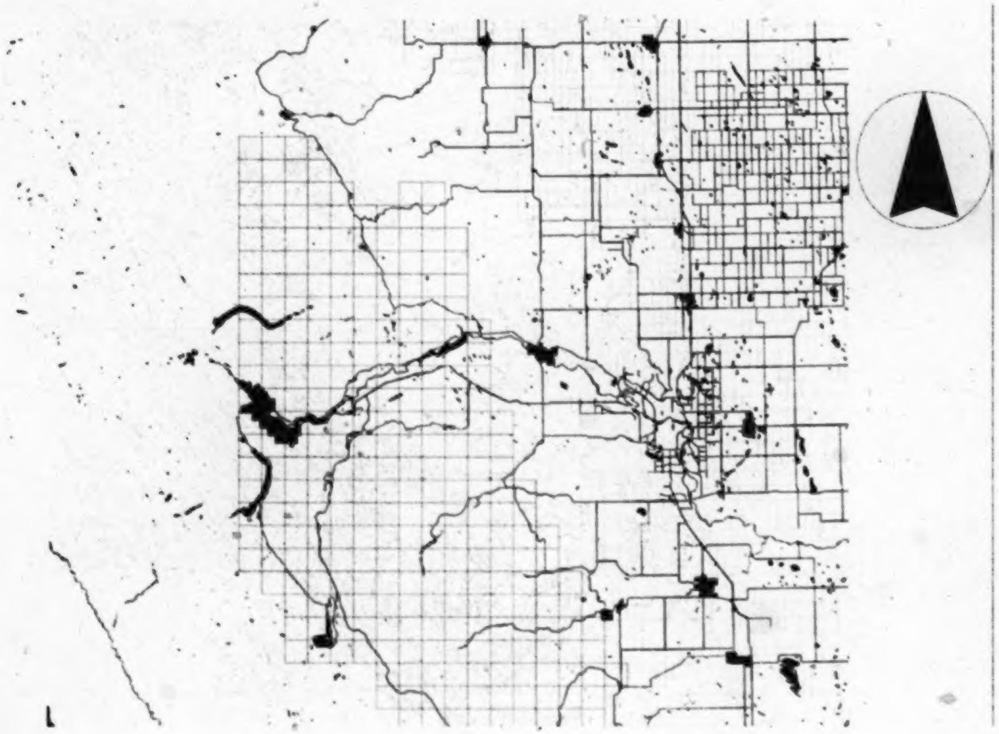
Appendix F. The Edson Area displayed in 25 km^2 grids.

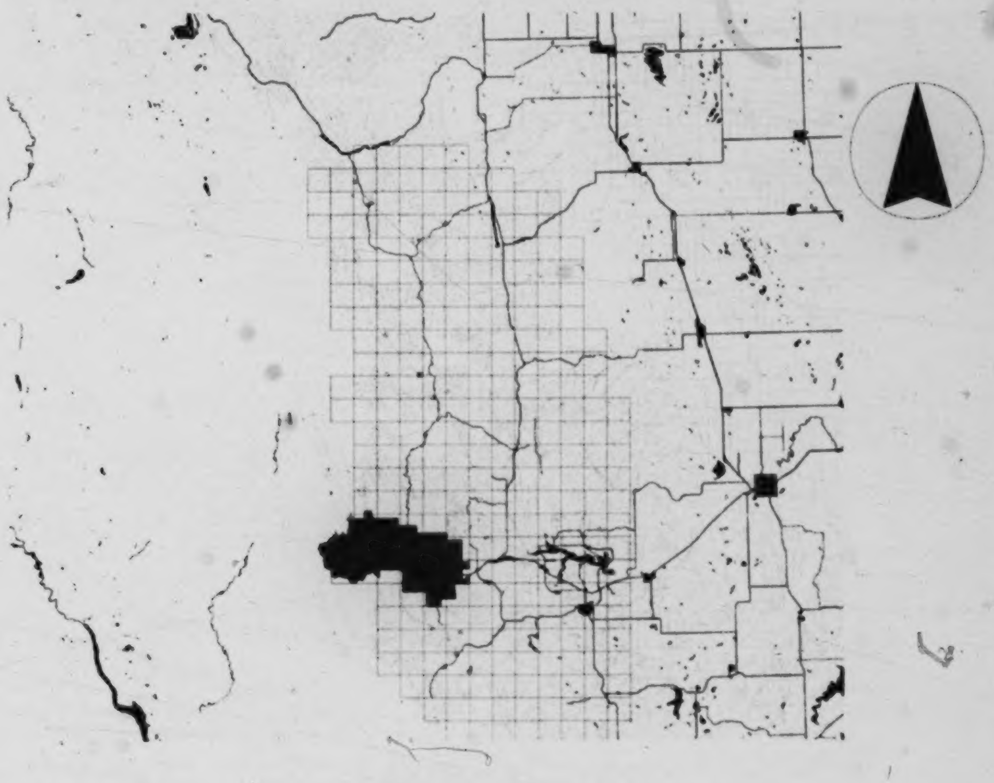

McLeod River
Erith
Embarras
Robb
Coalspur
Mercoal
40
Coal Valley
Foothills
Cadomin

Appendix G. The Rocky Mountain House Area displayed in 25 km^2 grids.



Appendix H. The Calgary Area displayed in 25 km^2 grids.



Appendix I. The Blairmore Area displayed in 25 km^2 grids.